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THE GARDENS’ BULLETIN, SINGAPORE

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Ridley, H.N. (1930) *The Dispersal of Plants Throughout the World*. Ashford, U.K.: L. Reeve.

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Front cover picture: *Didymocarpus kerrii* Craib (Photo by Preecha Karaket)

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Two new species of *Begonia* (Begoniaceae) from Bali and Lombok

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ABSTRACT. Two new species of *Begonia*, *B. lugrae* Ardhaka & Undaharta and *B. sendangensis* Ardi are described from Bali and Lombok, respectively. The species belong to *Begonia* section *Reichenheimia*. A checklist and identification key to the Bali and Lombok species of *Begonia* are provided.

Keywords. Bali, *Begonia*, Lombok, new species

Introduction

Begonia is one of the largest angiosperm genera, comprising approximately 1500 species which are distributed in tropical and subtropical Africa, America and Asia and Pacific Islands (Hughes 2008). The Southeast Asian species remain the most poorly known, with many novelties still being discovered recently (Girmansyah 2012; Sang et al. 2013; Phutthai et al. 2012). The first account dedicated to the *Begonia* of Bali and Lombok was published by Girmansyah (2009), which reported five new species and one new record, bringing the total number of species known from the two neighbouring islands to eight species.

During field surveys of *Begonia* in Gianyar, Bali in 2010 organised by the Bali Botanic Garden, and in Lombok in 2012 led by the Bogor Botanic Garden, two new species of *Begonia* were collected, here newly named as *Begonia lugrae* Ardhaka & Undaharta and *Begonia sendangensis* Ardi. All available specimens from ANDA, BO, E, K, L and SING have been consulted, and hence it must be assumed, at least until more intensive collecting in Bali may reveal otherwise, that the species have a very restricted range (Fig. 1). All the specimens cited are included in the Southeast Asian *Begonia* Database (Hughes & Pullan 2007), which is accessible online (<http://elmer.rbge.org.uk/begonia/>).

Four of the species are classified in *Begonia* sect. *Sphenanthera* (Hassk.) Warb., another four including the two new species are in *Begonia* sect. *Reichenheimia*

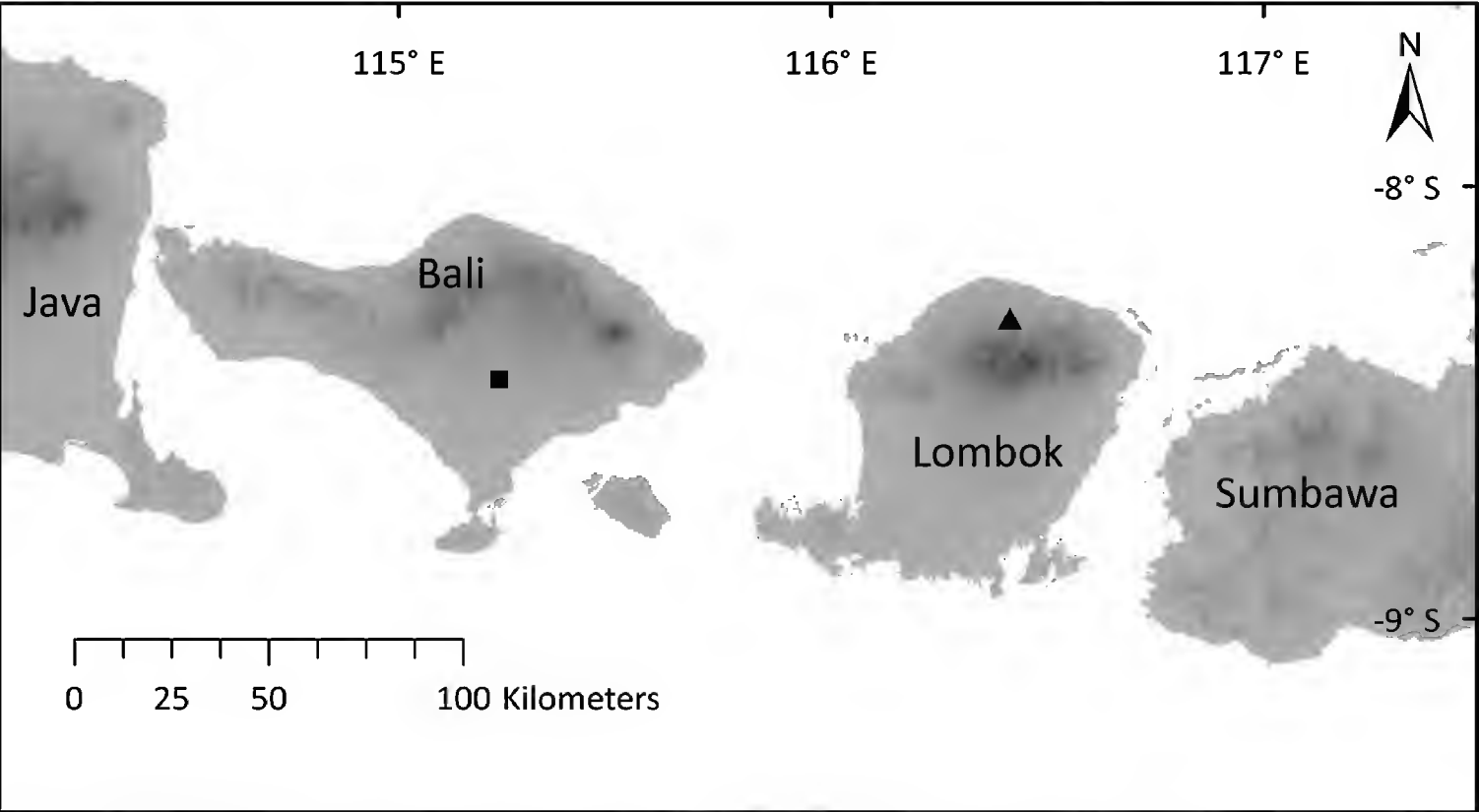


Fig. 1. Distribution of *Begonia lugrae* (squares) and *B. sendangensis* (triangles).

(Klotzsch) A.DC., and a single species each are in *Begonia* sect. *Parvibegonia* A.DC. and *Begonia* sect. *Petermannia* (Klotzsch) A.DC. (Table 1). The two new species exhibit typical characters of *Begonia* sect. *Reichenheimia*: rhizomatous or tuberous stems, protandrous inflorescences, and three locular ovaries with entire placentae (Doorenbos et al. 1998).

Table 1. The indigenous *Begonia* species of Bali and Lombok.

Section	Species
<i>Parvibegonia</i>	<i>Begonia tenuifolia</i> Dryand.
<i>Petermannia</i>	<i>Begonia lombokensis</i> Girm.
<i>Reichenheimia</i>	<i>Begonia coriaceae</i> Hassk.
	<i>Begonia lugrae</i> Ardhaka & Undaharta
	<i>Begonia sendangensis</i> Ardi
	<i>Begonia pseudomuricata</i> Girm.
<i>Sphenanthera</i>	<i>Begonia baliensis</i> Girm.
	<i>Begonia lempuyangensis</i> Girm.
	<i>Begonia longifolia</i> Blume
	<i>Begonia multibracteata</i> Girm.

Key to *Begonia* from Bali and Lombok

- 1a. Plant with erect stems..... 2
- b. Plant repent or stemless..... 6

- 2a. Female inflorescences basal to male; male and female flowers with 2 tepals; fruit a dry capsule with well developed equal wings *B. lombokensis*
- b. Female and male flowers occurring together in cymose inflorescences; male flowers with 4 tepals, female 5 or 6 tepals; fruit fleshy with reduced wings or one wing larger..... 3

- 3a. Fruit wings reduced to three equally short wings or ridges; lamina oblong to lanceolate; margin shallowly toothed to sub-entire; female flowers with 6 tepals..... *B. longifolia*
- b. Fruit with one larger wing; lamina ovate to broadly ovate; margin scalloped; female flowers with 5 tepals..... 4

- 4a. Inflorescence hairy; bracts persistent *B. multibracteata*
- b. Inflorescence glabrous; bracts caducous 5

- 5a. Lamina ovate; stem hairy *B. baliensis*
- b. Lamina broadly ovate; stem glabrous *B. lempuyangensis*

- 6a. Plants tuberous 7
- b. Plants rhizomatous 8

- 7a. Stem erect and weak; internodes elongated; inflorescence terminal, racemose; female flowers with 5 tepals; ovary with 2 locules; placentation bilamellate.....
..... *B. tenuifolia*
- b. Stemless; internodes compressed; inflorescences lateral, cymose; female flowers with 3 tepals; ovary with 3 locules; placentation entire *B. sendangensis*

- 8a. Leaves peltate..... *B. coriacea*
- b. Leaves basifixed 9

- 9a. Lamina 14–16.5 × 12–15 cm; margin crenate or minutely toothed to entire, peduncle shorter than petioles *B. lugrae*
- b. Lamina 5.5–10 × 5–9 cm; margin undulate, peduncle longer than petioles
..... *B. pseudomuricata*

The new species

Begonia lugrae* Ardhaka & Undaharta sp. nov. § *Reichenheimia

Similar to *Begonia pseudomuricata*, differing from that species by the broader, asymmetric stipules with a fleshy extension, subentire (not undulate) leaf margin, larger leaf lamina (14–16.5 × 12–15 cm) compared to in that species (5.5–10 × 5–9 cm), and the peduncle being shorter than the petioles.

TYPE: *Ni Kadek Erosi Undaharta RS 03*, cultivated at Bali Botanic Garden from vegetative material collected in the wild from Melinggih village, Yeh Ayung River, Gianyar, Bali, Indonesia, 08°26'50.3"S 115°13'55.9"E, 26 Jul 2013 (holo BO; iso E, KRB, Bali Botanic Garden Herbarium). Fig. 2.

Perennial, creeping, rhizomatous monoecious herb, 15–17 cm tall. **Stems** internodes short, 5–8 mm long, glabrous, reddish with white spots at the nodes; stipules semi-circular, 6–10 × 12–15 mm, asymmetric, pale green, with an abaxially prominent hirsute reddish midrib up to c. 15 mm long, persistent. **Leaves** alternate; petioles 24–33.5 cm long, glabrous, reddish at base and green towards to apex; lamina basifixed, 14–16.5 × 12–15 cm, asymmetric, ovate, base cordate, lobes overlapping, apex shortly attenuate, margin sub-entire, with minute recurved teeth at the end of the veins, adaxial surface glabrous, green, raised slightly between the veins; venation palmate, veins paler green above, primary veins 7–8. **Inflorescence** cymose, with 5–10 flowers, axillary, protandrous, bisexual; peduncles 19.5–27.5 cm long, pale green, glabrous; bracts sub-orbicular, red, c. 2 × 3 mm, margin slightly fimbriate, deciduous. **Male flowers:** pedicels 5–15 mm, glabrous; tepals 4, white, outer tepals 2, c. 13 × 16 mm, sub-orbicular, base slightly cordate, margin entire, apex rounded or slightly undulate, glabrous; inner tepals 2, c. 13 × 8 mm, narrowly obovate, glabrous; androecium yellow, symmetric, globose; stamens c. 90, filaments c. 1 mm long, fused at the base, anthers c. 3 mm long, obovate, dehiscing through lateral slits c. 1/2 as long as the anther, connective not projecting. **Female flowers:** pedicels 7–15 mm, glabrous, bracteoles absent; tepals 3, white, unequal, two outer tepals orbicular to sub-orbicular, 12 × 14 mm, margin entire, apex rounded or undulate, one inner tepal, narrowly obovate, 6 × 12 mm; ovary sub-globose, 8–9 × 6–7 mm (excluding wings), locules 3, placentation axile, placentae entire, wings 3, subequal, triangular, rounded at the base and cuneate at the apex, the widest point at the middle of the ovary, glabrous; stigmas 3, shallowly U-shaped, stigmatic surface once spirally twisted. **Fruits** not seen.

Distribution. Endemic to Bali, Gianyar District, Melinggih village, Yeh Ayung River embankment.

Habitat. This species grows on the shaded steep rocky cliffs in the Yeh Ayung River embankment at 630 m elevation.

IUCN Conservation category. *Begonia lugrae* is currently only known from a single population, which is not in a formally protected area. Although locally abundant,

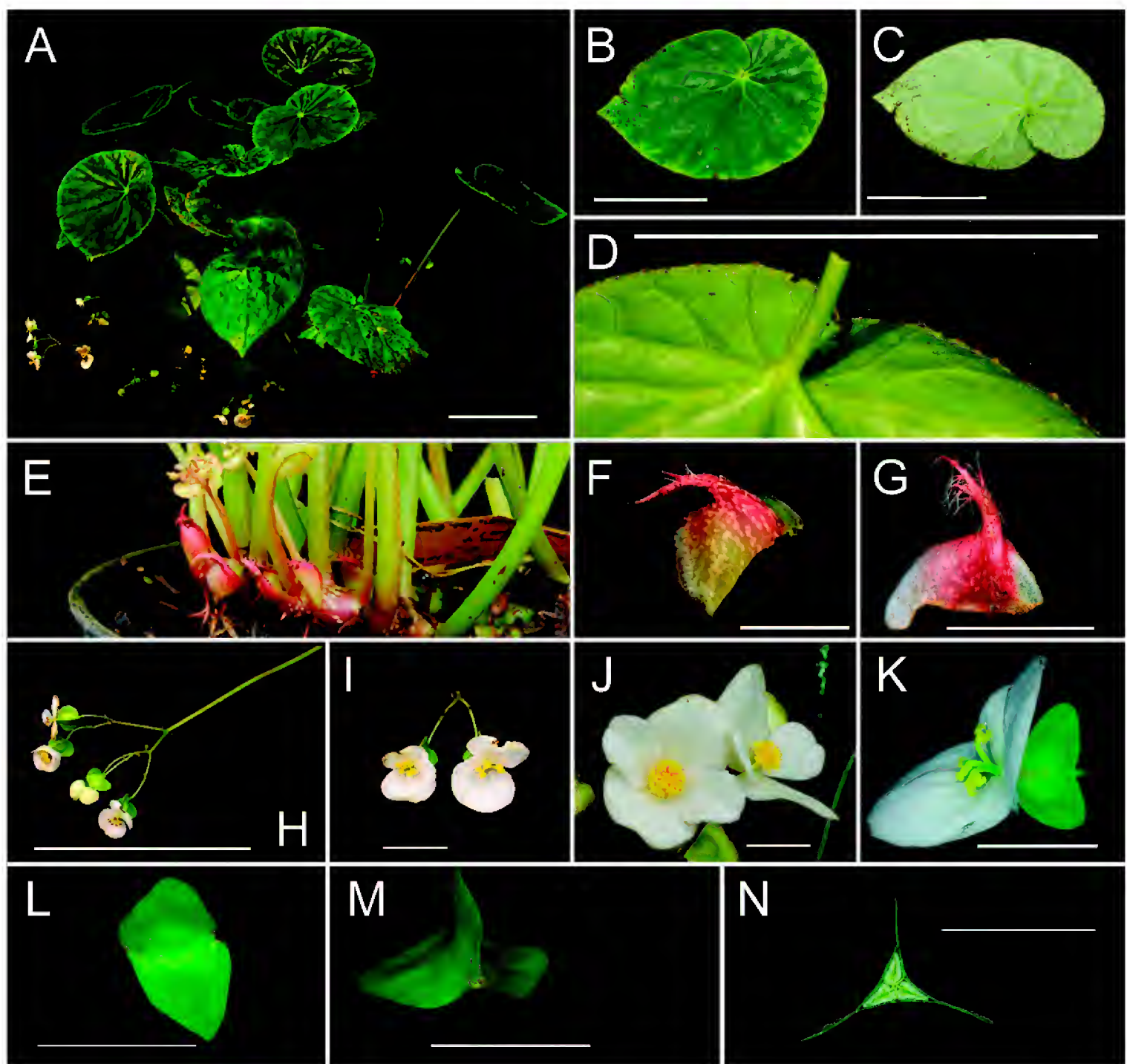


Fig. 2. *Begonia lugrae* from cultivated material in the Bali Botanic Garden. **A.** Habit. **B–D.** Lamina. **E.** Rhizomes. **F–G.** Stipule. **H–I.** Inflorescence. **J.** Male flowers. **K.** Female flower. **L.** Fruit, side view. **M.** Fruit, apical view. **N.** Ovary transverse section. Scale bars: J (1 cm); F, G, I, K–N (2 cm); A–D, H (10 cm). (Photos: A–I & K–N, Gede Wawan; J, Wisnu H. Ardi)

with at least 75 plants in the population, this makes the species vulnerable to future disturbance, and a provisional IUCN category of VUD2 is appropriate.

Notes. The species is named in honour of the Director of Bali Botanic Garden, I Nyoman Lugrayasa who generously supported many *Begonia* expeditions. This species is morphologically similar to *Begonia pseudomuricata* Girmansyah. However *B. lugrae* is distinct in its bigger leaves $14\text{--}16.5 \times 12\text{--}15$ cm (versus $5.5\text{--}10 \times 5\text{--}9$ cm) with sub-entire margin, whereas in *B. pseudomuricata* the margin is undulate. The length of the inflorescence peduncle and the shape of the stipules are further differences: the peduncles of *B. lugrae* (19.5–27.5 cm long) are always shorter than the petioles (24–33.5 cm long) while in *B. pseudomuricata* the peduncles (10–25 cm

long) are always longer than the petioles (5–20 cm long); in *B. lugrae* the stipules are very distinctive, being asymmetric and having a fleshy extension at the tip.

Begonia sendangensis* Ardi sp.nov. § *Reichenheimia

B. sendangensis differs from *B. pseudomuricata* and *B. lugrae* in its considerably smaller stature and in possessing a tuber; the latter character also distinguishes it from all other Indonesian species of *Begonia* sect. *Reichenheimia*.

TYPE: *WI* 82, cultivated at Bogor Botanic Garden from vegetative material collected in the wild from Senaru Village, Sandang Forest Reserve, Bayan Sub district, Lombok Utara District, Nusa Tenggara Barat, Indonesia, 08°18'23.3"S 116°24'47.9"E, 20 Apr 2013 (holo BO). Fig. 3.

Perennial, tuberous, monoecious herb, up to 10 cm tall. **Stems** very reduced, internodes c. 1 mm long; stipules, ovate, c. 3×1.5 mm, midrib prominent, sparsely hirsute, tip projecting c. 1.5 mm, persistent. **Leaves** alternate; petioles, 2.7–3.5 cm long, green, with scattered multicellular glandular hairs; lamina basifixed, $3.3\text{--}9 \times 2.7\text{--}6$ cm, asymmetric, ovate, base cordate, lobes rarely overlapping, apex attenuate, margin shallowly lobed, sparsely villose, with minute recurved teeth at the end of the veins, adaxial surface glabrous, green, raised slightly between the veins; venation palmate, veins pale green, primary veins 5–6. **Inflorescence** cymose, few-flowered, axillary, protandrous, bisexual; peduncles 2.5–3.9 cm long, pale green, glabrous; *bracts* minute, sub-orbicular, margin slightly fimbriate, deciduous. **Male flowers:** pedicels 14–20 mm long, tepals 4, pink, outer tepals 2, $10\text{--}12 \times 12\text{--}15$ mm, sub-orbicular, abaxially sparsely hairy, inner tepals 2, $11\text{--}13 \times 6\text{--}9$ mm, obovate to elliptic; androecium yellow, symmetric, globose, stamens c. 35, filaments fused at base into a short column c. 1.5 mm long; anther c. 1 mm long, narrowly obovate, dehiscing through lateral slits longer than half the length of the anther, apex retuse. **Female flowers:** 1 or 2, pedicels 15–17 mm long, bracteoles present, subulate, c. 2 mm long, persistent; tepals 3, pink, unequal, two outer tepals broadly ovate, c. $9\text{--}10.5 \times 14$ mm; sparsely hairy on abaxial surface, one inner tepal elliptic, 9.5×5.5 mm, glabrous; ovary $5\text{--}7 \times 5\text{--}5.5$ mm (excluding wings), ellipsoid, glabrous, green, locules 3, placentation axile, placentae entire, wings 3, equal, pinkish, rounded at base, rounded to truncate at apex, widest point 6–8 mm long just below the apex; stigmas 3, U-shaped, stigmatic surface once spirally twisted. **Fruit** with pedicel c. 15–18 mm long, capsule ellipsoid, c. 8×6 mm, (excluding wings), dehiscent, splitting along the wing attachments, wing shape as for the ovary, wings widest subapically, c. 8.5 mm wide.

Distribution. Endemic to Lombok, in the Sendang Gile Forest Reserve.

Habitat. This species grows on limestone cliffs in semi-shade.

IUCN Conservation category. *Begonia sendangensis* is probably a narrow endemic, restricted to the Sendang Gile Forest Reserve, where it does not form large colonies

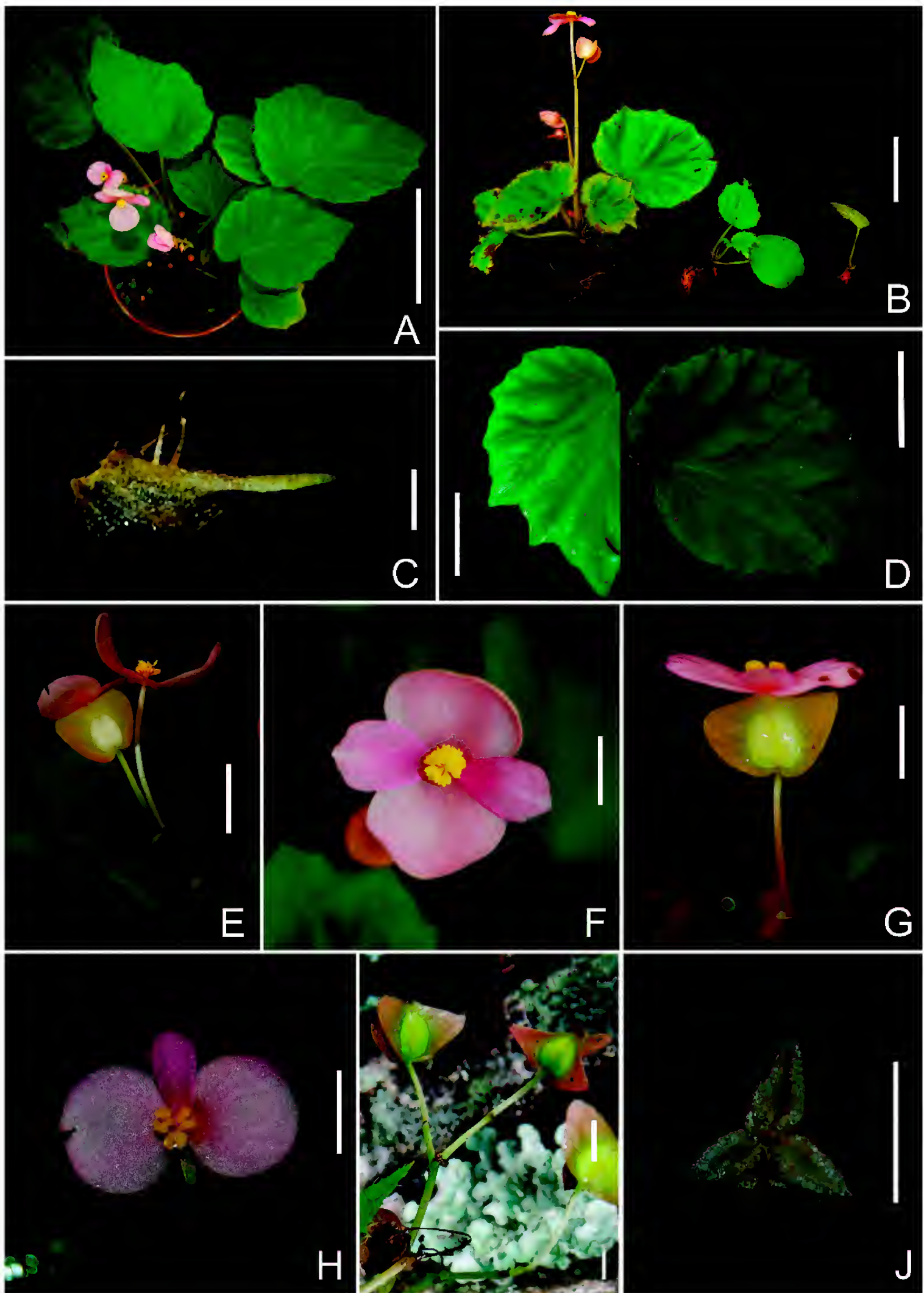


Fig. 3. *Begonia sendangensis*. **A–B.** Habit. **C.** Stipule. **D.** Lamina. **E.** Inflorescence. **F.** Male flower. **G.** Female flower showing ovary, side view. **H.** Female flower, top view. **I.** Fruit. **J.** Ovary transverse section. Scale bars: C (1 mm); J (5 mm); E–I (1cm); A, B, D (5 cm). (Photos: A–H & J, Wisnu H. Ardi; I, Syamsul Hidayat)

but appears to occur as scattered individuals on steep cliffs at the edge of the reserve. The narrow distribution and dependence on limestone means that a provisional IUCN category of VUD2 is appropriate, despite the area being protected.

Notes. The epithet '*sendangensis*' refers to Sendang Gile Forest Reserve from where the type material was collected. *Begonia sendangensis* is unique in *Begonia* section *Reichenheimia* in Indonesia on account of its tuberous habit. The presence of tubers in this species are probably an adaptation to its limestone habitat and the seasonally dry climate in the Lombok region. This is convergent with a number of other species which are found in the seasonally dry limestone habitats of continental Asia (southern China, Indochina, and the Thai Peninsula). Some of these are also currently in *Begonia* sect. *Reichenheimia* (e.g., *Begonia harmandii* Gagnep, *B. hymenophylla* Gagnep, *B. intermixta* Irmsch., *B. parvula* Irmsch.), but are likely to belong to the 'Diploclinium grade' (Rajbhandary et al. 2011) which has its centre of diversity in this area. The region also harbours most of the species in *Begonia* sect. *Parvibegonia* (e.g., *Begonia integrifolia* Dalzel., *B. bella* Putthai, *B. sinuata* Meisn.) which are characterised by the presence of tubers. Tuberous species are not well represented from the ever-wet areas of the Sunda shelf.

ACKNOWLEDGEMENTS. The authors would like to express gratitude to Ir. I Nyoman Lugrayasa (Bali Botanic Garden Director) for supporting *Begonia* expeditions on Bali; and to the curators of ANDA, BO, E, K, L and SING for allowing us access to herbarium material.

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***Marsdenia purpurella* (Apocynaceae: Asclepiadoideae), a new species from the Philippines**

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ABSTRACT. *Marsdenia purpurella* Fernando & Rodda, a new species from the Philippines, is described and illustrated. It is distinguished from all known species of *Marsdenia* from the Philippines in its rotate corolla lacking a corolline corona, simple umbelliform inflorescence, and very short peduncle.

Keywords. Apocynaceae, Asclepiadoideae, *Gymnema*, *Marsdenia*, serpentine soils

Introduction

Marsdenia R.Br. (Apocynaceae, Asclepiadoideae, Marsdenieae) includes about 300 species from tropical and warm temperate areas of the world, including Central and South America, Africa, the Mediterranean, Asia, Malesia, Australia, and Melanesia (Forster 1995b). The genus was revised, in part, for Asia, Malesia, and Australia (Forster 1995a, b), and now includes, among others, *Gymnema* R.Br. and *Dregea* E.Mey., two previously segregate genera also with representative species in the Philippines.

Merrill (1923) first recorded four species of *Marsdenia* for the Philippines, including three endemic species earlier described by Schlechter (Schlechter & Warburg 1904) and the widespread *Marsdenia tinctoria* R.Br. Two widespread species, *Marsdenia volubilis* (L.f.) Cooke, a species earlier enumerated by Merrill (1923) under *Dregea*, and *Marsdenia velutina* R.Br. (Forster 1995b), should now also be added to the list. Another two species, *Marsdenia tingens* (Roxb.) P.I.Forst., also a widespread species, and the Philippine endemic *Marsdenia pachyglossa* (Schltr.) P.I.Forst., were name combinations from *Gymnema* R.Br. (Forster 1995a). Six more Philippine endemic species of *Gymnema*, however, still need to be formally transferred to *Marsdenia*. Because the type materials for these six remaining species have not been available for examination and while awaiting the results of an extensive molecular phylogenetic study on *Marsdenia* (Livshultz pers. comm.), no name transfers are made at this time.

Following recent surveys of the metallophyte flora in the Philippines (Fernando et al. 2012), a new species of *Marsdenia* with woody climbing habit, clear exudate, umbelliform and unbranched inflorescences, and attractive greenish or yellow-green

flowers with purple tinge, was discovered in forest at middle elevations on Luzon Island. This particular taxon does not match any of the currently known species and is described below.

The new species

Marsdenia purpurella Fernando & Rodda, **sp. nov.**

Distinguished from all known species of *Marsdenia* from the Philippines in its rotate corolla lacking a corolline corona, simple, umbelliform inflorescence, and very short peduncle.

TYPE: *Fernando 2415*, Philippines, Luzon Island, Zambales Province, Candelaria, Malimlim area, in forest on serpentine soils, on gentle slope, 695 m elevation, 15°41'13"N 120°02'54"E, flowers and young fruit, 19 Apr 2011 (holotype LBC; isotypes CAHUP, K, PNH, SING). Fig. 1–2.

Terrestrial liana with clear and sticky exudate from stems and leaves. **Stems** woody, branching, up to 8 m long, climbing on tree stems and branches; base of stems 6–10 mm in diameter; adventitious roots not observed; stems climbing by twining, the apical part green, and covered with brownish indumentum, turning light brown, smooth when mature, then wrinkled, and lightly fissured towards the base; internodes 5–12.5 cm long on young growing stems, up to 3–7(–12) cm long, 3–4 mm thick on mature, flower-bearing stems. **Leaves** simple, opposite, petiolate; petiole terete, 5–10 × 1–2 mm; lamina obovate, very rarely elliptic to broadly elliptic, 5.4–10 cm long × 2–5 cm wide, smooth and glabrous on both surfaces, discolourous, adaxial surface glossy dark green, abaxial surface pale green or sometimes glaucescent, newly expanding leaves glossy green; secondary nerves 4–6 on each side of the midrib, diverging at 65–70° from the midrib, the tips joined by an intra-marginal vein; leaf base obtuse to cuneate, sometimes narrowly and shallowly cordate; apex apiculate to cuspidate; the lamina edges thickened and distinctly finely revolute when dry; colleters or glands sometimes present at base of lamina. **Inflorescences** axillary, one per node, umbelliform, unbranched, up to 4 cm long, 3–5 cm wide; flowers 15–23 per umbel, rather loosely arranged and arching or pendulous; in young plants the very first few inflorescences bear only single flowers with shorter pedicels; very young developing inflorescence covered with brown indumentum, subtended by 1 or 2 minute, leaf-like bracts, to 2–5 mm long. **Flower buds** ovoid, purple to purplish-brown, rather glossy, turning paler just before anthesis; aestivation imbricate, young buds pubescent; peduncle axillary, brown-hairy, 2–4 mm long, rather persistent, bracts at base of the flower pedicels persistent; pedicel 1.5–2.2(4) cm long, terete, 1 mm diameter, pale brown to purplish-brown, the very basal part attached to the peduncle purplish; sepals ovate or lanceolate, 1.5–2 × 1–1.5 mm, purplish-brown, sparsely pubescent outside, glabrous inside, ciliate. **Flowers** at anthesis up to 1.8 cm diameter; **corolla** rotate, 5-lobed, greenish or yellow-green to light yellow; the corolla lobes basally fused for

1.5–2 mm, lobes $7\text{--}7.5 \times 3.5\text{--}4$ mm, spreading, broadly lanceolate or linear, the distal portion lightly twisted, both surfaces smooth, glabrous, with slightly wavy, rather membranaceous margins; apices unequal, sometimes slightly twisted and strongly recurved, also with a purplish tinge; a darker mid-vein is faintly visible; corolline corona absent. **Staminal corona** not overtopping the style-head, c. 4.5 mm wide, 3 mm high, lobes 5, free, adnate to staminal column, same colour as the corolla, the central part of the corona purplish-white, adaxial appendages rounded to truncate, white on the outside and purple inside; style-head whitish at the tip and purple on the sides; alar fissures c. 2 mm long; **style-head** depressed-globose, 1–1.2 mm diameter. **Pollinarium** erect, with corpuscle and two pollinia; pollinium $300\text{--}340 \times 120\text{--}140$ μm , erect, nearly kidney-shaped or reniform, laterally attached near the base to the caudicles, pellucid margin absent; corpuscle narrowly ovoid, rather large, $260\text{--}300$ μm long $\times$ 150 μm wide, brownish; caudicles $140\text{--}170$ $\mu\text{m} \times 25$ μm ; ovary ovoid, 1.7–1.8 mm long $\times$ 1 mm wide. **Fruit** a follicle, solitary, pendulous; broadly ensiform to fusiform-ovoid, 9–10 cm long $\times$ 1.9–2.7(–3) cm wide $\times$ 1.2–2.5 cm thick, dull green or slightly glauscecent, the surface generally smooth, drying longitudinally ribbed; fruit cross-section oblong to nearly circular; many-seeded; pericarp 4–5 mm thick; pedicel 1.8–2.2 cm long $\times$ 1–1.5 mm wide; sepals persistent in fruit; juvenile fruit ovoid, glossy purplish-green; seeds broadly ovate, 10–12 mm long $\times$ 5–7 mm wide, coma 1.5 cm long.

Notes. The Philippine species of *Marsdenia* originally belonging to *Gymnema* or still to be transferred to *Marsdenia* present a corolline corona, whereas *Marsdenia purpurella* is distinct because it only has a staminal corona. Among the further four *Marsdenia* species from the Philippines, *M. philippinensis* Schltr., *M. tinctoria* R.Br., *M. velutina* R.Br., and *M. warburgii* Schltr. have branched or raceme-like inflorescences, whereas *M. purpurella* has simple, umbelliform inflorescences. *Marsdenia pergulariiformis* Schltr. inflorescences are similar to those of *M. purpurella*, but they are held by a longer peduncle (1.5–2 cm vs. 2–4 mm long). Further, the pedicels of the flowers of *M. pergulariiformis* are shorter (0.5–0.7 cm vs. 1.5–2.2(–4) cm long) and the flowers are campanulate, not rotate.

Distribution. Philippines: Luzon Island (Zambales Province) and Palawan Island. Endemic.

Specimens examined. PHILIPPINES. **Luzon Island.** Zambales Province, Candelaria, Malimlim area, 695 m elevation, open flowers and young fruit, 19 Apr 2011, *Fernando 2415* (holotype LBC; isotypes CAHUP, K, PNH, SING); ibidem, flower buds and immature fruits, 1 Apr 2012, *Fernando 3006* (LBC, PNH, SING); ibidem, newly developing flower buds, 18 Jan 2013, *Fernando 3081* (LBC); **Palawan Island.** Taytay, open flowers, May 1913, *Merrill 9355* (SING).

Etymology. The epithet *purpurella* refers to the purple tinge on the style head of the staminal corona and on the apices of the corolla lobes.

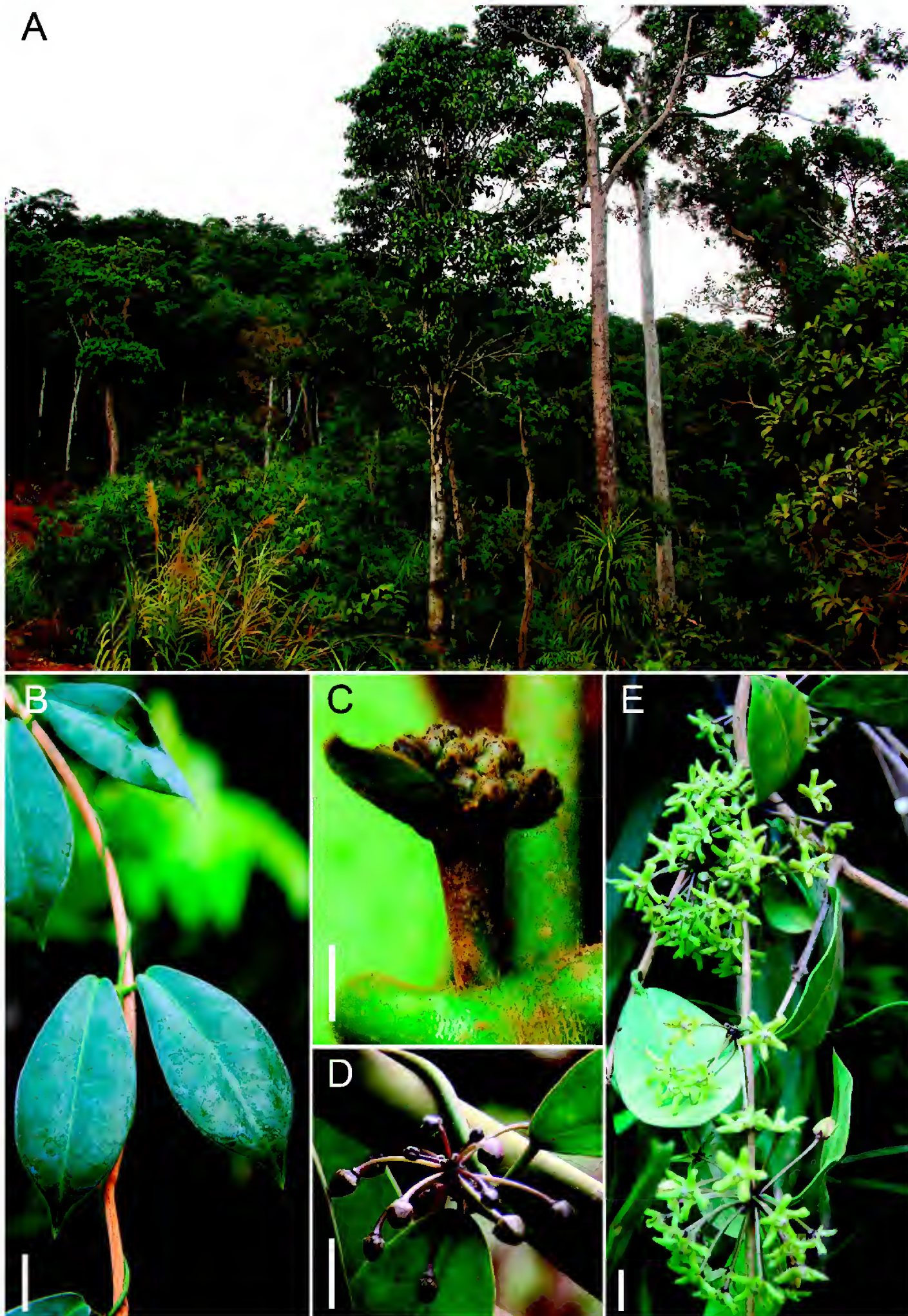


Fig. 1. *Marsdenia purpurella* Fernando & Rodda: **A.** Habitat at type locality. **B.** Young branch showing twining habit and leaf shape and arrangement. **C.** Newly emerging inflorescence. **D.** Flower buds. **E.** Mature stem with clusters of open flowers and one leaf showing abaxial surface. Scale bars: B, D, E (1 cm); C (1 mm). B & E from *Fernando 3006*; C from *Fernando 3081*; D from *Fernando 2415*. (Photos: Edwino S. Fernando)

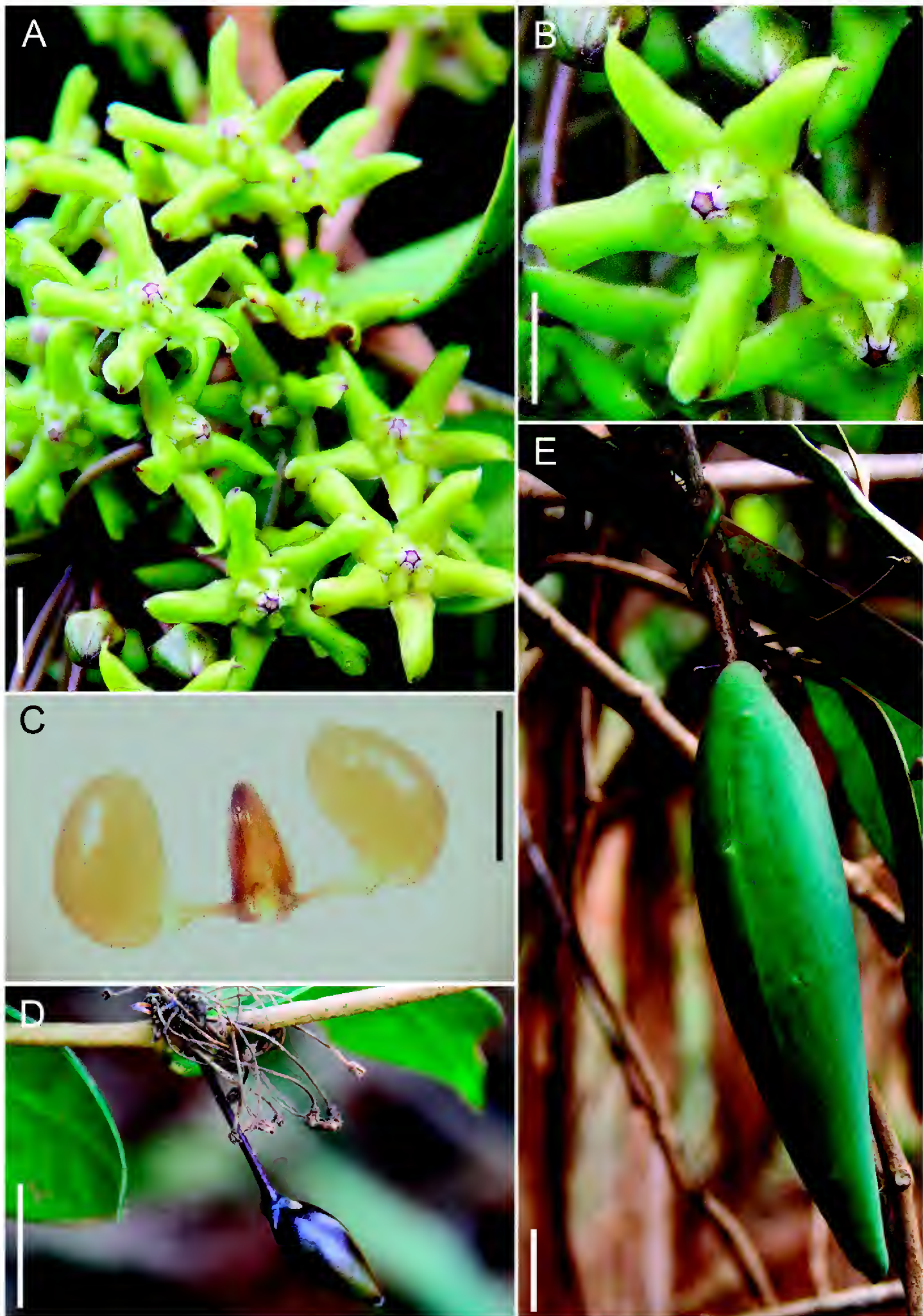


Fig. 2. *Marsdenia purpurella* Fernando & Rodda: **A.** Clusters of open flowers. **B.** Close up of a single flower showing discoid outline of staminal corona. **C.** Pollinarium with a rather large corpuscle and pollinia lacking pellucid margins. **D.** Young fruit. **E.** Immature fruit. Scale bars: A, B (5 mm); C (300 μ m); D, E (1 cm). A, B from *Fernando 2415*; C based on material in spirit, *Fernando 2415*; D, E from *Fernando 3006*. (Photos: Edwino S. Fernando)

Habitat and ecology. The type specimen of this species was discovered in forest on serpentine soils on a gentle slope at about 695 m elevation. The trees in this area may reach up to 20 m tall and includes the nickel hyperaccumulator *Rinorea bengalensis* (Wall.) Kuntze. Some of the other common plants that grow together with this species include the bamboo *Schizostachyum lumampao* (Blanco) Merr. and the rattan *Calamus vidalianus* Becc. Other species of Apocynaceae seen in this area are the white-flowered vine *Parameria laevigata* (Juss.) Moldenke and the epiphytic shrubs *Hoya multiflora* Blume and *H. cumingiana* Decne., although these are infrequent. Chemical analyses of the soil from this particular area in Zambales indicate 0.53–0.81% nickel, 0.28–0.40% cobalt, and 24.09–29.55% iron (Fernando et al. unpubl. data). The Palawan specimen (Merrill 9355) was collected from Taytay, a non-ultramafic area in the northern part of the island.

Conservation status. We consider this species to be Endangered (EN B12ab(ii,iii,iv)). Its extent of occurrence is estimated to be less than 5000 km², and thus far, it is known only from two distant locations in the Philippines. A continuing decline is observed, inferred, and projected in its (a) area of occupancy; (b) area, extent and/or quality of habitat, and (c) number of locations or subpopulations. Part of the area of the type locality in Zambales is subject to open pit mining for heavy metals. The other locality in Palawan is now largely degraded habitat and thus far represented only by a single century-old collection.

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Clarification of Hermann H. Kunstler's botanical collecting localities in Peninsular Malaysia

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ABSTRACT. Kunstler's collections made in Gopeng, Perak, in 1880 had labels wrongly printed with 'Larut'; herbarium specimens from Ulu Bubong, Ulu Kerling, and Sungai Kul were wrongly localised as from Perak instead of from Selangor; 'G.M.' on Kunstler's labels from his 4th expedition to Gopeng in 1885, which included plants restricted to limestone, refers to Gunung Mesah south of Gopeng (not Gunung Megua or Gunung Malacca, names that do not exist, nor does it refer to Gunung Bujang Melaka, a granite peak south of Kampar, Perak); lastly 'near G.M.' probably refers to Gunung Tempurong, Perak. *Paraboea capitata* Ridl. and *P. vulpina* Ridl., both strict calcicoles, were not collected from G. Bujang Melaka as was reported by Ridley.

Keywords. Gopeng, Gunung Bujang Melaka, Gunung Mesah, Gunung Tempurong, limestone, Perak, Selangor, Ulu Bubong

Introduction

The first Flora to deal with Peninsular Malaysia was J.D. Hooker's seven volume *Flora of British India* (1872–1897) based on herbarium collections at the Royal Botanic Gardens, Kew, U.K., and Calcutta, India. However, owing to a paucity of herbarium specimens at that time the results are very incomplete. George King, Director of the Royal Botanic Garden Calcutta, therefore organised systematic botanical collecting in Peninsular Malaysia in order to enable him to undertake the first detailed and comprehensive *Materials for a Flora of the Malay Peninsula* (begun in 1889 and completed together with other botanists in 1936). He arranged with Sir Hugh Low, then British Resident at Perak, to employ plant collectors to make good this collections deficit. Between 1880 and 1886, Benedetto Scortechini, a Jesuit priest, and Hermann H. Kunstler, a German explorer from Australia, collected specimens that were sent to Calcutta with duplicates to Kew (Burkill 1927). For this reason many of the labels on Kunstler's specimens record him as 'King's Collector' rather than as Kunstler. The Singapore Herbarium later acquired a partial set of Kunstler's specimens. Kunstler's specimen labels are exemplary in the detail they give of characters that cannot be seen in dried herbarium specimens, as well as often providing information on habitat. He collected about 11,000 numbers, with many becoming the type specimen for a plethora of new species described as the flora of the Malay Peninsula was becoming

better known, including more than a hundred named in his honour, such as *Homalium kunstleri* King and *Plectranthus kunstleri* Prain, both species that he collected from limestone in Perak.

Kunstler's botanical collecting localities

With the patronage of Sir Hugh Low, Kunstler collected mostly in Perak, in the Larut and especially in the Gopeng district. The latter in his day was a centre for tin-mining, which had already resulted in extensive degradation by forest clearing and the silting of river systems, and where around Kuala Dipang the forest was being opened up for European plantations (Burkill 1927). Narayanaswami (1931) in his article on the *Provenance of Early Plant Collections* provided a useful itinerary of Kunstler's collecting trips based on information from his diaries and drew attention to some confusion about the exact location of Kunstler's collecting localities. Unfortunately, to date, there is no database of Kunstler's specimens making it difficult to directly trace his itinerary in detail. Narayanaswami's list was extracted from Ridley's five volume *Flora of the Malay Peninsula* (1922–1927) but Ridley, in reporting a species' distribution did not always provide a specimen number and/or precise locality, and in any case Narayanaswami's list is incomplete. Although Narayanaswami was based in the Calcutta herbarium, he does not appear to have consulted the first set of Kunstler's specimens there.

In spite of information provided by Burkill (1927) and Narayanaswami (1931), inaccuracies continue to appear in the literature concerning the localities where Kunstler collected. Three sources of error are clarified below.

1. Labels printed 'Larut' that were collected from the Gopeng District

Narayanaswami (1931) has drawn attention to the labels for Kunstler's specimens collected from the Gopeng District between August and December 1880 being mistakenly printed 'Larut' in Calcutta, although the actual collecting locality is clearly written on the label.

2. Specimens collected in northern Selangor but recorded as from Perak

Narayanaswami (1931) reported that Kunstler in January and between March and August 1886 'crossed the borders of Perak and wandered in Northern Selangor'. However, the herbarium labels, while clearly providing the correct locality (Table 1), placed them in Perak and not Selangor. Unfortunately, this correction has been overlooked and the majority of botanists still cite these localities as in Perak, not in Selangor.

Narayanaswami (1931) is correct in surmising that Kunstler's locality 'near K.L.' is probably between Ulu Bubong and Ulu Selangor because, for example, *Codonoboea pectinata* (Oliv.) Kiew (*Kunstler 10711*) recorded from 'near K.L.' is hyper-endemic to

that part of the Main Range. The herbarium label records *C. pectinata* from limestone, but it is in fact a calcifuge species. This is the single instance of inaccurately recorded rock type.

Table 1. Kunstler’s collecting localities in northern Selangor frequently incorrectly cited as being in Perak.

<i>Locality</i>	<i>District</i>	<i>Latitude and longitude</i>
Ulu Bubong	Hulu Selangor	3°31'N 101°43'E
Ulu Kerling	Hulu Selangor	3°35'N 101°36'E
Sungai Kul ¹	Hulu Selangor	3°35'N 101°45'E

¹often written by Kunstler as Kal. For current correct names and spelling of botanical collecting localities see Hamidah et al. (2011).

3. Location of Kunstler’s limestone collecting localities

Even more confusion has arisen over Kunstler’s collecting localities from limestone hills in Perak. There are at least 45 limestone hills in the Kinta valley presently named on topographical maps (Malayan Nature Society 1991). However, Kunstler did not name specific hills on his specimen labels but instead noted the area where they occurred, such as Kinta, Gopeng, and Kuala Dipang (which he spelt Goping and Kwala Depang, respectively). Perhaps because he could obtain the name of a river or village from local people, the two exceptions were Sungai Raia, which he variously spelt as Sungei Raia, Rayah, Ryah, Ryoh, and Gunung Mesah (4°26'N 101°10'E), spelt Meusah on older maps. Sungai Raia rises in the Main Range and flows east past Gunung Datoh (4°36'N 101°09'E), a limestone karst hill, then southwest to the confluence with Sungai Kinta near Batu Gajah (Malayan Nature Society 1991) while Gunung Mesah, which is a few miles south of Gopeng, is the site of a Malay village. Incidentally he never used ‘Ipoh’ as a locality. (In his time Ipoh was a village at the highest navigable point on the Kinta River. Ipoh only developed into a town in the early twentieth century when the British Tin-mining Company, followed by several banks, were established there).

Burkill (1927) reported that Kunstler set up his headquarters in Gopeng (4°28'N 101°10'E), which is an area rich in limestone hills. Altogether he made four expeditions in the Gopeng area and since he was careful to specify soil type, the plants from limestone can be identified. Henderson (1939) noted that Kunstler, or the clerk transcribing labels, consistently spelt limestone as ‘limbstone’ or shortened it to ‘limbs’ or ‘limbs hills’, occasionally giving ‘Limbo Hills’ as the locality. In addition, in most cases it is possible to use the label data of species known to be restricted to limestone substrate to check whether the locality recorded is limestone or not.

1st Expedition to Gopeng, Kinta District, in 1880

(From Narayanaswami's incomplete list, Kunstler's collecting numbers run from at least 449 to 985).

<i>Months:</i>	<i>Locality:</i>
August–September, November	Gopeng
October	Sungai Raia

This first expedition included several species restricted to limestone, such as *Monophyllaea hirticalyx* Franch. (Kunstler 449) and *Paraboea capitata* Ridl. var. *oblongifolia* Ridl. (Kunstler 456) from Gopeng; *Monophyllaea elongata* B.L.Burt (King's Coll 674) from Kinta; *Paraboea capitata* var. *capitata* (Kunstler 978) and *Epithema saxatile* Blume (Kunstler 983) from Sg. Raia; and *Saprosma glomerulatum* King & Gamble (Kunstler 783) and *Thunbergia laurifolia* Lindl. (Kunstler 1064) from G. Mesah.

2nd Expedition to Gopeng, Kinta District, in 1883

(From Narayanaswami's incomplete list, Kunstler's collecting numbers run from at least 4177 to 4814).

<i>Months:</i>	<i>Locality:</i>
June–August	Gopeng

The second expedition included hills to the north of Gopeng, probably around Gunung Rapat (4°34'N 101°08'E). Apparently few limestone species were collected, but he did, however, collect *Paraboea capitata* var. *capitata* (King's Coll. 4325) from Sg. Raia at this time.

3rd Expedition to Gopeng, Kinta District, in 1884

(From Narayanaswami's incomplete list, Kunstler's collecting numbers run from at least 5872 to 6031).

<i>Months:</i>	<i>Locality:</i>
April–May	Gopeng

The third expedition collected plants from the east of Gopeng from the Chenderiang area and included a few limestone plants, such as *Epithema saxatile* (Kunstler 5872).

4th Expedition to Gopeng, Kinta District, in 1885

(From Narayanaswami's incomplete list, Kunstler's collecting numbers run from at least 7026 to 7222 for specimens collected from Gopeng, and 8130 to 8424 for specimens collected around Kuala Dipang and Sungai Siput Selantan).

<i>Months:</i>	<i>Locality:</i>
January	Gopeng, 'G.M.', Gunung Mesah
September–October	Kuala Dipang/Sungai Siput Selantan

The last expedition visited Kuala Dipang (4°23'N 101°10'E), which is a village southeast of Gopeng. Many collections from limestone were made, such as *Plectranthus kunstleri* Prain (*King's Coll.* 8240), *Paraboea caerulescens* (Ridl.) B.L.Burt (Kunstler 8276) and *Paraboea paniculata* (Ridl.) B.L.Burt (Kunstler 8271).

It was from this expedition that the confusion of the identity of the locality written as 'G.M.' originates. Narayanaswami (1931, pg 329) mistakenly supposed it to be Gunung Bujong Melaka, writing that in January 1885 Kunstler 'went to Gunong Bujong Malaka (sometimes written as G.M. and mistaken for Gunong Mesah)' even though labels bearing 'G.M.' clearly state the plants are from limestone. It is likely that Narayanaswami was not aware of the different geology of the two hills: Gunung Bujang Melaka (4°20'N, 101°12'E, old spelling Gunong Bujong Malacca) is a granite peak on the Main Range just outside Kampar; while Gunung Mesah is a limestone tower karst hill south of Gopeng.

The issue has been further confused because Ridley in his Flora interpreted 'G.M.' as 'Gunong Malacca', a place name that does not exist on maps. That his Gunong Malacca is a limestone hill is seen by his recording Kunstler's specimens of *Impatiens alboflava* Miq. (Kunstler 7057) and *Sonerila elliptica* Stapf from 'limestone rocks in Perak, Kinta District'. However, some specimens such as *Strobilanthes pachyphylla* C.B.Clarke (Kunstler 7150) he did record as from 'Gunung Meusah, Kinta'.

This error that 'G.M.' was Gunung Bujang Melaka was repeated by Steenis-Kruseman (1950) and Burt (1978). However, one way to solve the provenance of these G.M. specimens is to check whether they are plants that grow on limestone or granite. For example, *Monophyllaea elongata* is a species restricted to limestone. Burt (1978), who described this as a new species, drew attention to *King's Coll.* 7052 where the label recorded that it was collected from 'Kinta, near G.M' and 'has pencilled alongside the G.M of the label "Gunong Magua"?'. It is not known who wrote Gunong Magua (perhaps a clerk?), because the handwriting does not correspond to any botanists' handwriting who has studied Malaysian plants. However, Gunong Magua does not exist as a place name. Burt followed Narayanaswami's conclusion that it was Gunong Bujong Malaka. This is certainly an error because *Monophyllaea elongata* has an extremely restricted distribution and is confined to limestone substrate.

Another specimen that Ridley (1923) localised as from 'Kinta, Gunong Megua' was *King's Coll.* 7191 that he identified as *Didissandra glabrescens* Ridl., now considered as a synonym of *Ridleyandra atrocyanea* (Ridl.) A.Weber, and that is known only from granite substrate, never from limestone, and for which Ridley (1923) gave its locality as 'Bujong Malacca'. In this instance Weber (1998) is correct in thinking that G.M./Gunong Megua 'certainly means Gunung [Bujang] Melaka'.

Gunung Mesah was revisited to check if the plants recorded from 'G.M' or 'near G.M.' grow on this limestone hill. Although the surrounding forest has been cleared for village orchards, agriculture and fish farms, the hill itself is relatively untouched. A Chinese temple that occupied the cave has been abandoned. Fortunately the hill has been spared from quarrying, unlike Gunung Panjang, the next small hill to the south that is already half consumed by an active quarry. Gunung Mesah is a relatively low hill reaching 262 m altitude and the summit, although craggy, is covered by a deep leaf litter layer that supports a complete tree canopy with *Hopea bilitonensis* P.S.Ashton as a dominant species. Without a database of Kunstler's specimens, it is difficult to extract a complete list of plants that he collected. However, three that Kunstler had collected there were recollected after an interval of 125 years, namely *Thunbergia laurifolia* (Kunstler 1064), *Paraboea capitata* var. *oblongifolia* (Kunstler 456), and *Monophyllaea hirticalyx* (Kunstler 449).

Notable is a group of species collected by Kunstler in January 1885 that were recorded as from 'near G.M.' but were not refound on G. Mesah. These include species, such as *Callicarpa angustifolia* King & Gamble (Kunstler 8236), *Homalium kunstleri* King (Kunstler 7109), *Paraboea caerulescens* (Kunstler 7062, 7175), and *Paraboea parviflora* (Kunstler 7108), that grow on exposed summits of limestone hills where the trees are stunted and the canopy is open. This habitat is found on the summit of Gunung Tempurong (4°25'N 101°12'E), the highest limestone karst in Perak that reaches 611 m altitude. In addition, it is one of the two localities from which *Paraboea parviflora* is known. *Monophyllaea elongata* (King's Coll. 7052) is another hyper-endemic species that is known only from Gunung Tempurong, where it grows in abundance on damp, vertical rock faces around the base of the hill, where a river runs out of the cave. Such a habitat does not exist on Gunung Mesah.

Gunung Tempurong houses the largest cave in Peninsular Malaysia so it was surely known to local people, who could act as guides. However, the name Gunung (Mount) or Gua (Cave) Tempurong was not cited as a collecting locality by Kunstler, C. Curtis nor Ridley, nor it is mentioned by Burkill (1927). However, the present distribution of these hyper-endemic species, and their exacting habitat requirements, leads to the conclusion that Kunstler's locality 'near GM' refers to G. Tempurong.

One enigma remains, namely from where *Paraboea capitata* was first collected. Ridley described *Paraboea capitata* from a specimen collected by Curtis (Curtis 3215) in December 1895 that gave 'Bujong Malacca' as its provenance in spite of it being a strict calcicole. This is likely due to a simple error caused by a mix up of specimens because in December 1895 Curtis had collected both on limestone hills in Ipoh and Kuala Dipang as well as on Gunung Bujang Melaka (Burkill 1927). (Later in the Penang Botanic Gardens, Curtis grew plants from this gathering that he also supplied to Ridley who described them as new species, *Paraboea curtisii* Ridl. and *P. polita* Ridl., in spite of the specimens having the same collecting number, Curtis 3215. They are now both synonyms of *P. capitata* var. *capitata*). Subsequent collections show that *P. capitata* var. *capitata* is quite common on limestone hills around Ipoh town but since Curtis did not number his specimens in a strict sequence, it is not possible to know exactly where he collected Curtis 3215. Ridley (1923) described *P. vulpina*

Ridl., another strict calcicole, from a collection from the Hot Springs in Ipoh (*Curtis* 3132), which is a limestone locality, as well as recording this species from 'Bujong Malacca' but without citing the collector. However, this latter specimen has never been found and until about 20 years ago this species was known only from a limestone hill at the Hot Springs, Ipoh (Burt 1984). In this case too, it is clear that 'Bujong Malacca' is a mistake.

Conclusion

Until a complete database for the specimens that Kunstler collected becomes available, it is not possible to track his itinerary in detail. Many of Kunstler's collections are type specimens or are of rare species, several of which have not been recollected. Being able to pinpoint his collecting localities has implications for taxonomy and conservation because it would allow a search of these places to enable the collection of complete material of problematic species and assessment of their conservation status. This is because, in the intervening 125 years, many of his collecting localities are likely to have become degraded and their habitats may no longer exist having been replaced by tin-mines or plantations.

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Studies on the Araceae of the Lesser Sunda Islands I: New distribution records for *Alocasia alba*

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ABSTRACT. *Alocasia alba* Schott is a new record for the islands of Bali and Lombok, in the Indonesian Lesser Sunda Islands. An expanded description is given, and the species illustrated from living plants. A key to species of *Alocasia* for the Lesser Sunda Islands is provided.

Keywords. *Alocasia alba*, aroids, Indonesia, Lesser Sunda Islands, new record

Introduction

The Lesser Sunda Islands (LSI) comprise many small islands of two countries, Indonesia (the majority of the islands), and Timor Leste (comprising the eastern portion and a discrete north western enclave of Timor Island). In Indonesia, administratively, the LSI belong to three provinces: Bali, Nusa Tenggara Barat (comprising Lombok and Sumbawa Islands), and Nusa Tenggara Timur (comprising Sumba and Flores Islands, and most of the western half of Timor Island). The LSI are among the least well investigated parts of Malesia for many families, including the Araceae, although in the past five years fieldwork in the LSI focusing on Araceae has been undertaken by the first and second authors. One aim of this fieldwork has been to establish a living research collection in the Bali Botanical Garden, an essential prerequisite for working on the aroid flora. From this so far three novelties from Sumbawa and Lombok have been identified (one species of *Alocasia* and two of *Homalomena*), all as yet undescribed, together with at least 10 new species records for Bali.

Alocasia comprises about 100 species of mainly understory herbs from humid evergreen tropical and subtropical forest in Asia and Australia (Boyce 2007, 2008; Hay 1998, 1999, 2000; Hay & Wise 1991; Kurniawan & Boyce 2011; Medecilo et al. 2007; Nauheimer et al. 2012). The latest monograph for *Alocasia* of West Malesia and Sulawesi is Hay (1998), since when several additional species have been described from Borneo (Hay 2000; Boyce 2007, 2008; Kurniawan & Boyce 2011). A recent phylogeny of *Alocasia* by Nauheimer et al. (2012) suggested several dispersal events leading to speciation in Malesia, and revealed that *Alocasia* and *Leucocasia* (formerly

Colocasia gigantea (Blume) Schott formed a lineage separate from the rest of the *Colocasieae sensu* Mayo et al. (1997).

Hay (1998) records only one *Alocasia* species for the Lesser Sunda Islands, the widespread cultivated/feral and certainly non-indigenous *A. macrorrhizos* (L.) G.Don. Over the course of fieldwork on Bali and Lombok, plants of what are without doubt *A. alba* (Fig. 1) have been encountered in habitats well-away from possible human introduction, such that we are now confident that *Alocasia alba* is naturally occurring on these islands, representing a new distributional record for a species until now considered primarily a Javan species (Hay & Yuzammi 2000).

Alocasia alba Schott, Oesterr. Bot. Wochenbl. 2: 59 (1852); Miq., Fl. Ind. Bat. 210 (1856); Schott, Syn. Aroid. 48 (1856); Schott, Prod. Syst. Aroid. 149 (1860); Engl., in A. & C.DC., Monogr. Phan. 2: 500 (1879); Hook.f., Fl. Brit. India 6: 528 (1893); Hay, Gard. Bull. Singapore 50: 289 (1998); Hay & Yuzammi, Curtis's Bot. Mag. 17(3): 216–220, Pl. 403 (2000). TYPE: Schott Icones nos. 86–88 (neotype W, designated by Hay 1998). [fiche 68: d6–d8 in the microfiche edition].

Alocasia bantamensis Koord., Bull. Jard. Bot. Buitenzorg III, 1: 162 (1918); K. Krause, in Engl. & K. Krause, Pflanzenr. 71(IV.23E): 84 (1920); Koord., Exkurs.-Fl. Java 4: 195–196, fig. 395–396 (1923); Backer & Bakh.f., Fl. Java 3: 119 (1968). TYPE: *S. H. Koorders 41445β*, Indonesia, Java, Bantam, Danoe-moeras, 26 May 1912 (Lectotype L!, selected by Hay 1998).

Alocasia crassifolia Engl., in Engl., Pflanzenr. 71: 82 (IV.23E) (1920); Koord., Fl. Tjibodas 6 (1922). TYPE: *A. Engler 4101*, Indonesia, Java, Hort. Bogor, Jan–Feb 1906 (holo B!).

Large, stout, often helophytic, pachycaul, up to 2 m tall; **leaves** several together, held erect and declined near post mature, petiole green, whitish-greenish at the sinus, with scattered yellowish glands, up to 170 cm long, sheathing in the lower, 1/4–1/3 of its length, persistent wings, green-purplish, straight to recurved; **blade** thick, rather stiff,

Fig. 1. *Alocasia alba* Schott. **A.** Plants in natural habitat in Bali's Batukaru Reserve. **B.** Plants from Mt. Rinjani, East Lombok in cultivation at the Bali Botanical Garden. **C.** Inflorescence at onset of staminate anthesis. Note that the spathe limb has reflexed and is just beginning to degrade. **D.** Plant from Bali, Munduk Pengubengan, with inflorescence at pistillate anthesis, nearside part of lower spathe artificially removed. Note the erect spathe limb; at this stage the stigmas are sticky. **E.** Detail of the spadix of same inflorescence as D, at staminate anthesis. Note that the spathe limb has reflexed (just visible) and that pollen release has started. At this stage the stigmas are hardly sticky. **F.** Detail of the upper portion of staminate flowers and lower part of appendix. **G.** Plant at early fruiting stage, West Lombok. Note that the infructescences are paired. A from *Ni Putu Sri Asih 30*; B from *Wayan Warnata 775*; C from *Agung Kurniawan 338*; D–F from *Bayu Adjie 753*; G no voucher. (Photos: A, D, E & F, Ni Putu Sri Asih; B–C, Gede Wawan Setiadi, used with permission; G, Agung Kurniawan).



slightly bullate, green adaxially, greenish-green abaxially, broadly ovato-sagittate to cordato-sagittate, margin entire; **anterior lobe** c. 80 cm long, c. 75 cm wide at base, apex shortly acuminate; anterior midrib with up to 11 primary veins diverging at 40°–60°, prominent on both surface with conspicuous small flat glands in the axils abaxially; secondary veins impressed adaxially, prominent abaxially, interprimary collective vein well-defined; submarginal vein 1–2 mm from margin; **posterior lobes** obtuse c. 45 cm long from the sinus; **inflorescence** in groups of up to c. 10, not interspersed with foliage leaves (but occasionally occurring as a solitary pair of inflorescences); peduncle up to 38 cm long, with scattered small broadly elliptic glands; **spathe** to c. 17 cm long, constricted at level of sterile zone of the spadix, lower spathe broadly ovoid-cylindric, c. 5 cm from the base, green-ivory greenish, the limb reflexed between staminate zone and sterile zone, thinly leathery, greenish yellow to greenish white, up to 12 cm long; **spadix** cylindrical, c. 15 cm long, sessile to very shortly stipitate; **pistillate flower zone** c. 1.7–2.2 cm long, 1–1.4 cm wide, with c. 60–100 pistils, densely arranged; ovary green, ovoid to subglobose, 2–3 mm in diam.; style abruptly-differentiated from ovary and c. 1 mm long, to lacking; stigma white-ivory-yellowish, 2–3 lobed, **sterile interstice** c. 1–1.6 cm long, with c. 5–6 whorls of rhombo-hexagonal synandrodia, the lowermost whorls isodiametric with pistillate zone and resembling sterile synandria; **staminate flower zone** ivory, c. 2.5–3.5 cm long, c. 1–1.5 cm wide; synandria white-ivory, swollen-topped, rhombo-hexagonal, 2 mm diam., thecae overtopped by synconnective; appendix ivory, c. 5.5–8 cm long, tapering, smooth to faintly rugose and composed of irregular sinuous staminode, basally isodiametric to or slightly narrower than the staminate zone; fruiting peduncle to c. 25 cm long; fruiting spathe broadly ovoid, to 6 cm long; fruit ellipsoid, orange, 5 mm.

Distribution. Widespread at low to medium elevation on Java. Hay (1998) stated he saw plants likely to be *A. alba* near Telukbetung, on the Palembang road, SE Sumatera in 1996, but circumstances prevented preparation of a voucher. This observation is supported by a collection in Leiden (barcode L 0295537), determined by Schott as *A. alba*, with label data stating Telukbetung.

Specimens examined from LSI localities. INDONESIA. **Bali:** Tabanan District, Batukaru Reserve, 08°22'18"S 115°06'15"E, *Ni Putu Sri Asih* 30 [Bali Botanical Garden Accession E2012100002]; Tabanan District, Pengelengan Hill, 08°15'27"S 115°10'26"E, *Agung Kurniawan* 338 [Bali Botanical Garden Accession E2011073]; Karangasem District, Munduk Pengubengan, 08°21'31"S 115°27'48" E, *Bayu Adjie* 753 [Bali Botanical Garden Accession E20110952]. **Lombok:** East Lombok District, Mt Rinjani, 08°19'42"S 116°30'08"E, *Wayan Warnata* 775 [Bali Botanical Garden Accession E20100797].

The material listed above is vouchered by specimens kept in the Herbarium of the Bali Botanical Garden. In addition to the above vouchered material, the first author saw *A. alba* growing in Aik Nyet Village (08°32'01"S 116°14'05"E), West Lombok District in 2010.

Ecology. In open and shaded areas in forest, edge of forest, beside roads and fields, sandy-stony soil in river banks, on well-drained soils, in Bali and Lombok found at 300–1300 m asl.

Notes. *Alocasia alba* is known from four locations in the Lesser Sunda Islands: three on Bali, and one on Lombok. Plants at all sites are similarly characteristic with prominent primary veins on both surfaces of the blade, with the sinuous interprimary collective veins abaxially very well-defined, and the sinus of the posterior whitish in colour, the spadix with the lowermost whorls of synandrodia isodiametric with the pistillate zone, the style abruptly-differentiated from ovary, and 2–3 lobed stigmas. However there is some variation in plants between the four sites. Plants at Pengelengan Hill (Tabanan, Bali) have a sessile spadix with the sterile interstice and pistillate flower zones of equal length and some of the stigmas deeply lobed and ivory in colour, and the leaf blade cordato-sagittate. These morphological traits are shared by plants of *A. alba* at the Batukaru Reserve (Tabanan, Bali). Furthermore *A. alba* from Batukaru Reserve (Bali) has the longest staminate zone than other *A. alba*, a staminate zone of somewhat equal length to the sterile appendix, the most slender sterile interstice compared to other *A. alba*, and a sterile interstice almost equal to or shorter than the pistillate zone. Plants of *A. alba* from Munduk Pengubengan (Karangasem, Bali) have the spadix sessile, and white-yellowish stigmas, with the sterile interstice shorter than the pistillate zone, and a leaf blade ovato-sagittate in outline, with the petiolar sheath proportionately shorter than the other *A. alba* (c. 1/4 length of petiole).

Alocasia alba from Mount Rinjani (Lombok) has a very shortly stipitate spadix, white stigmas, a sterile interstice shorter than pistillate zone, but longer than in other populations, and a leaf blade cordato-sagittate in outline.

Key to Species of *Alocasia* in the Lesser Sunda Islands

- 1a. Leaf blades without interprimary collective veins or these poorly-defined; inflorescences paired among leaf bases, spathe 13–35 cm long, limb membranous; stigma yellow, 3–5-lobed, appendix yellowish (widespread in ruderal situations, naturalised) *A. macrorrhizos*
- 1b. Leaf blades with well-defined interprimary collective veins, inflorescences forming a dense cluster at the apex of the stem, not interspersed with foliage leaves (sometimes a solitary pair of inflorescence); spathe c. 17 cm long, thin-leathery; stigma white-ivory-yellowish, 2–3-lobed, appendix ivory *A. alba*

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***Calanthe punctata* (Orchidaceae), a new species from southern Myanmar**

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ABSTRACT. A new species of *Calanthe* (Orchidaceae) from southern Myanmar is described and illustrated. The new species belongs to subgenus *Preptanthe* (Rchb.f.) Schltr. and is very distinctive with its upright and strongly red-dotted petals. Differences from *C. labrosa* (Rchb.f.) Hook.f. which appears to be its closest relative are discussed.

Keywords. *Calanthe*, Orchidaceae, southern Myanmar

Introduction

The orchid flora of Myanmar is among the poorest known in continental Asia which is largely caused by periods of past instability and political isolation of the country (Ormerod & Sathish Kumar 2003). According to recent estimates about 800 different orchid species are known to occur in Myanmar (Ormerod unpubl.; Kurzweil unpubl.), but this number is likely to grow in the near future. Several new distribution records or descriptions of entirely new species have been published in the last few years (e.g., Ormerod 2002, 2006, 2012; Ormerod & Sathish Kumar 2003, 2008; Ormerod & Wood 2010; Nyunt 2006; Kurzweil et al. 2010; Kurzweil & Lwin 2012a, b; Tanaka et al. 2011; Watthana & Fujikawa in press), and further floristic exploration of the country will most likely result in additional discoveries.

Material of an unknown *Calanthe* species was recently collected during an orchid survey trip in and around Taninthayi Nature Reserve in southern Myanmar, and was sent to the author of the present paper for identification. The genus *Calanthe* is rather well represented in Myanmar; about twenty-three species are currently known to occur in the country (Ormerod unpubl.), with all of them belonging to widespread taxa and none being endemic. The specimen from Taninthayi turned out not to match any known species of the genus, and is therefore described as new.

***Calanthe punctata* Kurzweil, sp. nov.**

Similar to *Calanthe labrosa* (Rchb.f.) Hook.f. but differing by green sepals, green and strongly red-dotted petals and a 3-lobed lip.

TYPE: Myanmar, Taninthayi Region, about 45 km north of Dawei, Yae Kan Taung, degraded forest, 700 m, 22 Nov 2012, *Saw Lwin, Pan Khet Khet & Zaw Oo Wai TNRO 153* (holo SING; iso Myanmar Floriculturist Association). Fig. 1–2.

Erect lithophytic or terrestrial herb, deciduous, 24–43 cm tall. **Basal sheaths** not seen. **Pseudobulbs** prominent, ovoid or conical, mostly constricted in the middle, 5.4–7.5(–13.5) × 2.5–3.75 cm, adjacent, several-noded, covered by thin and dry pale brown leaf sheaths, glabrous. **Leaves** not present at the flowering time (but see note below). **Inflorescence** arising from the pseudobulb base, erect, nodding in the apical part, softly pubescent; sterile bracts: 3–5 borne along the stem plus a few clustered at its base, lanceolate-oblong, acute or acuminate, pubescent, dry during the flowering time, lower sterile bracts erect or suberect and largely sheathing, 2–3 cm long, upper sterile bracts spreading and to 1.5 cm long; raceme lax, 3- to 7-flowered, pubescent; floral bracts persistent, ovate-lanceolate or broadly ovate-lanceolate, long-acuminate, the lower 15 × 8 mm, much shorter than the pedicel plus the ovary, pubescent. **Flowers** with green sepals and petals, lip white with pink-flushed side lobes, spur green; petals and lip side lobes strongly red-dotted; column pink, anther whitish. **Sepals** ovate-lanceolate, aristate-acuminate, strongly hairy on the outside, very sparsely hairy on the inside, 3-veined, reflexed and revolute; median sepal 9–10 × 4.9–5.4 mm; lateral sepals 9.5–10 × 5.2–6 mm. **Petals** elongate ovate-elliptic, apex variable from acute to subacute, donkey ear-like pointing upwards, 3- to 5-veined, glabrous, lateral edges and apex bent backwards and petals therefore appearing narrow and apically blunt, 12.5–14 × 4.4–5.1 mm. **Lip** 10–11.5 × 12.8–14 mm, 3-lobed with the side lobes inserted at ± right angle when spread out, lip blade attached to the distal end of the column-foot but not united with the sides of the column as in most species of *Calanthe* subgenus *Calanthe*, with a basal claw to 2 × 4 mm, lower part of lip blade a strongly convex hump with three obscure ridges; midlobe ovate, obtuse, 6.5–8 × 8–9 mm; side lobes oblong, obtuse, 5–5.5 × 3–3.8 mm, erect and enveloping the column; spur cylindric, slender, 15–16 mm long, pubescent, straight, parallel to the ovary. **Column** 3–3.5 mm long, glabrous, with a 2–3 mm long column-foot. **Ovary** (including pedicel) 28–32 mm long, densely and softly pubescent. **Fruit** not seen.

Distribution. Currently only known from the type collection made in southern Myanmar. *Calanthe punctata* is currently the only *Calanthe* species endemic to Myanmar.

Ecology. The type specimen was found growing on rocks in degraded forest at about 700 m altitude.

Phenology. Flowering from late October till November. Fruiting season not known.

Etymology. The new species is named after the prominently punctate petals.

Notes. *Calanthe punctata* is very distinctive with its green, reflexed and revolute sepals, the green and strongly red-dotted donkey ear-like petals, and the white and pink-flushed three-lobed lip with red spotting. It seems closest to *C. labrosa* which also occurs in Myanmar (Seidenfaden 1995; Chen et al. 2009; Clayton & Cribb 2013). This species has similar reflexed sepals and some spotting on its lip and more rarely also on the petals, but differs by having entirely pink or white flowers and an unlobed lip.



Fig. 1. *Calanthe punctata* Kurzweil. **A.** Habit. **B.** Flowers. (Photos: Saw Lwin)

The leaves of the new species could not be examined as they were not present at the flowering time. However, about two months before the collection of the type specimen of the new species, several plants of a *Calanthe* with well-developed leaves were found at the same locality. It is likely that these were also specimens of the new species. Their leaves can be described as follows: leaves 4, plicate, lanceolate-oblong, acute or shortly acuminate, 24–29 × 6.9–9.6 cm; petioles 2–3 cm long and forming a short pseudostem.

A preliminary study of the development of the flower of *Calanthe punctata* indicates that the column-foot is a compound structure. Its median tissue, stretching from the proximal part of the column-foot to its apex, is derived from the lip base; as a consequence the lip spur is inserted in the proximal part of the column-foot. In contrast, the two lateral portions of the column-foot are derived from bulges that are developed on the column in early development, and therefore constitute column tissue. It appears that these lateral bulges are identical to the ‘ventral structures’ previously observed in *Calanthe* × *veitchii* Hort. in early ontogeny (Kurzweil 1987: 433–434), where they were interpreted as probably representing vestiges of the adaxial stamens (which in orchids are generally not developed as prominent organs). It is here assumed

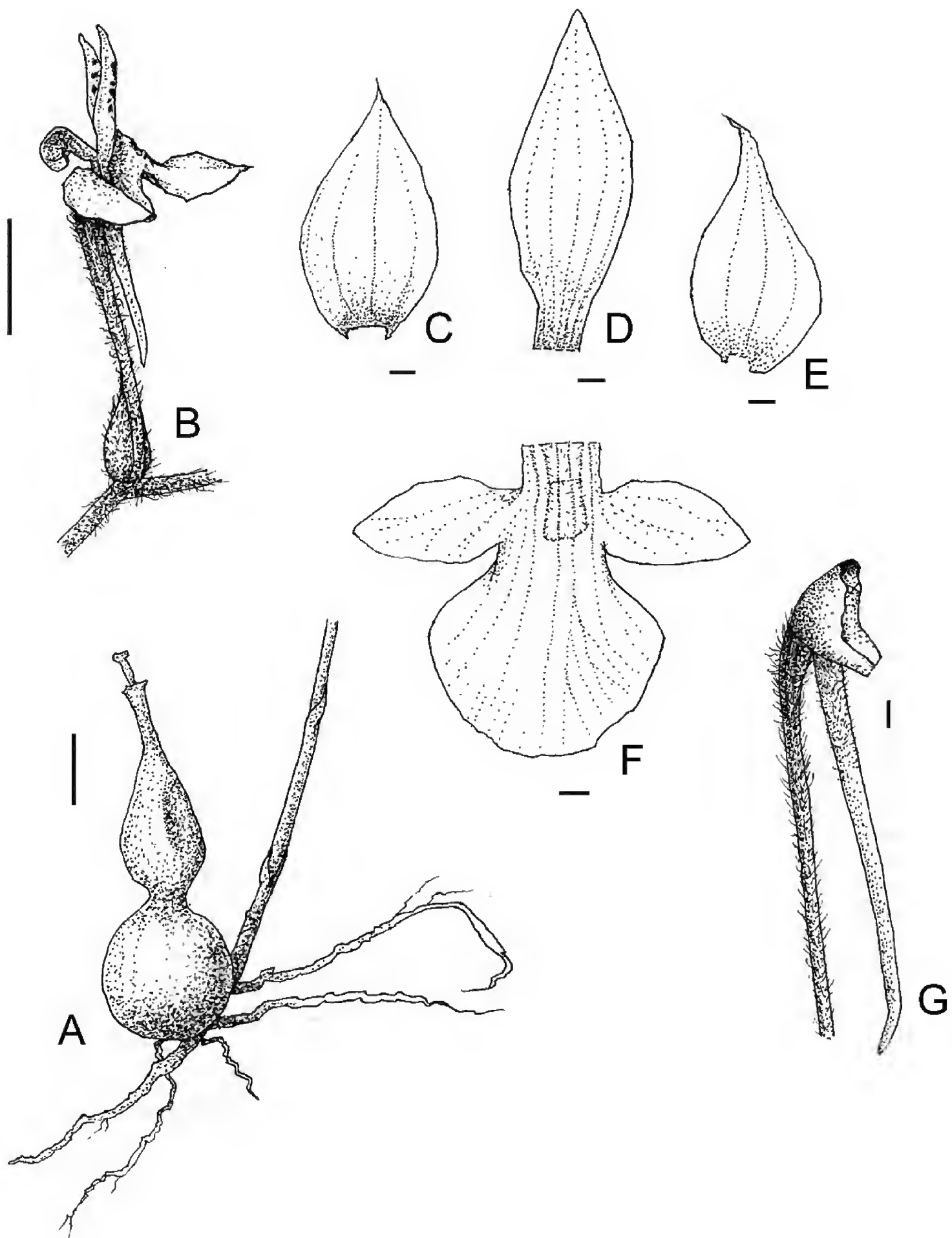


Fig. 2. *Calanthe punctata* Kurzweil. **A.** Pseudobulb. **B.** Flower in side view. **C.** Median sepal. **D.** Petal. **E.** Lateral sepal. **F.** Lip. **G.** Column and lip spur. Scale bars: A–B = 10 mm; C–G = 1 mm. (Drawn by Evonne Tay)

that this mode of development is also found in other related species of this *Calanthe* group.

The new species belongs to *Calanthe* subgenus *Preptanthe* (Rchb.f.) Schltr. which is a small group of only about 8–9 species centred in mainland Asia (Myanmar, Thailand, Indochina, south-western China and Peninsular Malaysia) although ranging into Malesia. The plants are characterised by prominently swollen pseudobulbs, deciduous leaves, and long- and soft-hairy inflorescences. The large green, greyish green or brownish green pseudobulbs are more or less ovoid and frequently constricted in the middle. It is thought that the prominent pseudobulbs are an adaptation to the periodically dry growing conditions found in many parts of mainland Asia. Although primarily terrestrial, some species in the group grow as lithophytes on limestone cliffs or occasionally as epiphytes in forest, which is also facilitated by the large pseudobulbs. As already suggested by Seidenfaden (1975) two distinct subgroups can be recognised in subgenus *Preptanthe*. The subgroup including *C. vestita* Wall. ex Lindl. and *C. rubens* Ridl. is characterised by an extensive fusion of the lip base and the sides of the column like in most species of *Calanthe* subgenus *Calanthe*. Both species have a three-lobed lip with deeply bilobulate midlobe. The second subgroup includes *C. succedanea* Gagnep., *C. cardioglossa* Schltr., *C. hirsuta* Seidenf., *C. rosea* (Lindl.) Benth., *C. labrosa* as well as the new species, and is characterised by having a lip which is not united with the sides of the column. The lip of this subgroup is unlobed or three-lobed and always has an entire or more or less emarginate midlobe.

As the new species is currently known from a single collection and the orchid flora of Taninthayi is generally poorly known, an assessment of its conservation status can obviously not be made. According to the notes supplied by the collector, the new species was only seen in this one locality where it was rather abundant.

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Two new species of *Curcuma* subgen. *Ecomata* (Zingiberaceae) from southern Vietnam

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ABSTRACT. Two new species of *Curcuma* subgenus *Ecomata* (Zingiberaceae) from southern Vietnam, *C. newmanii* Škorníčk. and *C. xanthella* Škorníčk., are described and illustrated here. Their similarities and differences from their closest allies in the subgenus *Ecomata*, *C. singularis* Gagnep. and *C. flaviflora* S.Q.Tong, are discussed.

Keywords. *Curcuma flaviflora*, *Curcuma newmanii*, *Curcuma singularis*, *Curcuma xanthella*, Zingibereae, Zingiberoideae

Introduction

The Indochinese region is one of the diversity hotspots for the Zingiberaceae. With the last comprehensive account over a century old (Gagnepain 1908), the ginger flora is not well known. During our extensive explorations of the family for the Flora of Cambodia, Laos and Vietnam, numerous interesting ginger species have been recently described including a new genus *Newmania* from Vietnam (Lý et al. 2010; Leong-Škorníčková et al. 2011; Lamxay & Newman 2012; Nguyen & Leong-Škorníčková 2012; etc.) and six *Curcuma* species. Four of the *Curcuma* species are from the subgenus *Ecomata* Škorníčk. & Šída f. (Záveská et al. 2012)—*C. vitellina* Škorníčk. & H.Đ. Trần (Leong-Škorníčková et al. 2010b), *C. pambrosima* Škorníčk. & Lý (Leong-Škorníčková & Lý 2010), *C. corniculata* Škorníčk. ined. and *C. flammea* Škorníčk. ined. (Leong-Škorníčková et al., submitted), while two others are from the subgenus *Hitcheniopsis*—*C. pygmaea* Škorníčk & Šída f. ined. (Leong-Škorníčková et al., in press) and *C. leonidii* Škorníčk. & Luru (Leong-Škorníčková & Luru 2013).

With the progressing revision of the genus *Curcuma* for Indochina, another two species from the subgenus *Ecomata* were found to be new and are described and illustrated below (Fig. 1, 2, 3 & 5). The terminology follows Beentje (2012). The new species, *C. newmanii* and *C. xanthella*, are morphologically close to *C. singularis* Gagnep. and *C. flaviflora* S.Q.Tong (Fig 4.) and for this reason they are compared to them here. The recent molecular phylogeny of the genus *Curcuma* (Záveská et al. 2012) showed that *C. newmanii* and *C. xanthella* cluster with other Vietnamese species from the the subgenus *Ecomata* and that they are distinct from *C. singularis* & *C. flaviflora*.

***Curcuma newmanii* Škorničk., sp. nov.**

Similar to *Curcuma singularis* Gagnep., but differs by its unique shape of anther characterised by short anther spurs with two blunt knobs at apex (forming a heart-shaped structure in front view) and longer, more prominent lateral staminodes.

TYPE: *Trần 204*, Vietnam, Đắk Lắk Prov., Bản Đôn village, 12°55'11.07"N 107°49'16.32"E, alt. 205 m, 27 April 2010 (holo SING; iso VNM). Fig. 1.

Rhizomatous herb to 0.8 m tall. **Rhizome** ovoid, 2–4 × 1–1.5 cm, light brown externally, cream white internally; *root tubers* not seen, likely to be well distanced from the rhizome. **Leafy shoot** with 3–6 leaves, developing at the same time or shortly after flowering; *pseudostem* to 30 cm long, green, composed of leaf sheaths; *sheathing bracts* 1–3, tinged with dark red-purple, fast drying out and decaying; *leaf sheaths* green, with red-purple tinge especially towards the basal part, puberulent; *ligule* up to 3 mm long, bilobed, hyaline, greenish white, translucent, externally puberulent; *petiole* up to 11 cm long (petiole of outermost leaf shortest, innermost leaves longest), canaliculate, green, puberulent; *lamina* slightly unequal, narrowly lanceolate (sensu Lindley), up to 32 × 8 cm (possibly larger later in the season), slightly plicate, adaxially medium to dark green with a dark red band running along the midrib across the entire lamina length, glabrous, abaxially lighter green, puberulent; base obtuse, slightly oblique; apex caudate, puberulent. **Inflorescence** lateral, peduncle and often also base of the spike subterranean; *peduncle* c. 3 cm long, up to 5 mm diam., cream-white, with up to 4 sheathing bracts; *spike* 4–6 cm long, c. 2–3 cm diam. in the middle, wider apically, coma absent; *fertile bracts* 3–8 per inflorescence, bract 4.5 × 4 cm (larger at the base of the inflorescence, inner ones gradually smaller and narrower), broadly ovate to ovate with acute apex, whitish at base, green with various degree of deep red tinge towards the apex, both sides puberulent, connate in the lower 1/3–1/4, apex narrowly acute, reflexed; *cincinni* with 2–3 flowers at the base of the inflorescence, 1 flower at the top; *bracteoles* rudimentary, thread-like and irregularly curled, 1–3 × 0.5–1 mm (outer ones larger, inner ones are gradually smaller), hyaline, translucent white, glabrous. **Flower** c. 8 cm long, much exerted from the bracts; *calyx* up to 23 mm long, 3-toothed, with unilateral incision c. 10 mm, translucent white, sparsely puberulous; *floral tube* 3.5–4.5 cm long, externally white, densely puberulous throughout, internally white, glabrous at basal half, densely puberulous in apical half, with dorsal groove holding the style; *dorsal corolla lobe* c. 25 × 10 mm, triangular ovate, concave, glabrous, pure white, apex mucronate, mucro c. 2 mm long, puberulous; *lateral corolla lobes* c. 20 × 9 mm, triangular ovate, concave, glabrous, pure white; *labellum* c. 26 × 20 mm, obovate, apex emarginate, incised up to 5 mm, white except a bright yellow median band, puberulent with glandular hairs; *lateral staminodes* c. 26–30 × 16–18 mm, irregularly obovate, white with short glandular hairs on the adaxial side. **Stamen** 10–11 mm long; *filament* 2–3 mm long, white, c. 4 mm broad at base, 2–2.5 mm broad at apex (the point of attachment to the connective), covered with short glandular hairs; *anther* c. 10 mm long (measured along side view with spurs unmanipulated), spurred; *connective* white, densely covered with short glandular hairs; *anther spurs* c. 1 mm long, with two blunt knobs at apex (forming a heart-shaped structure in front view);

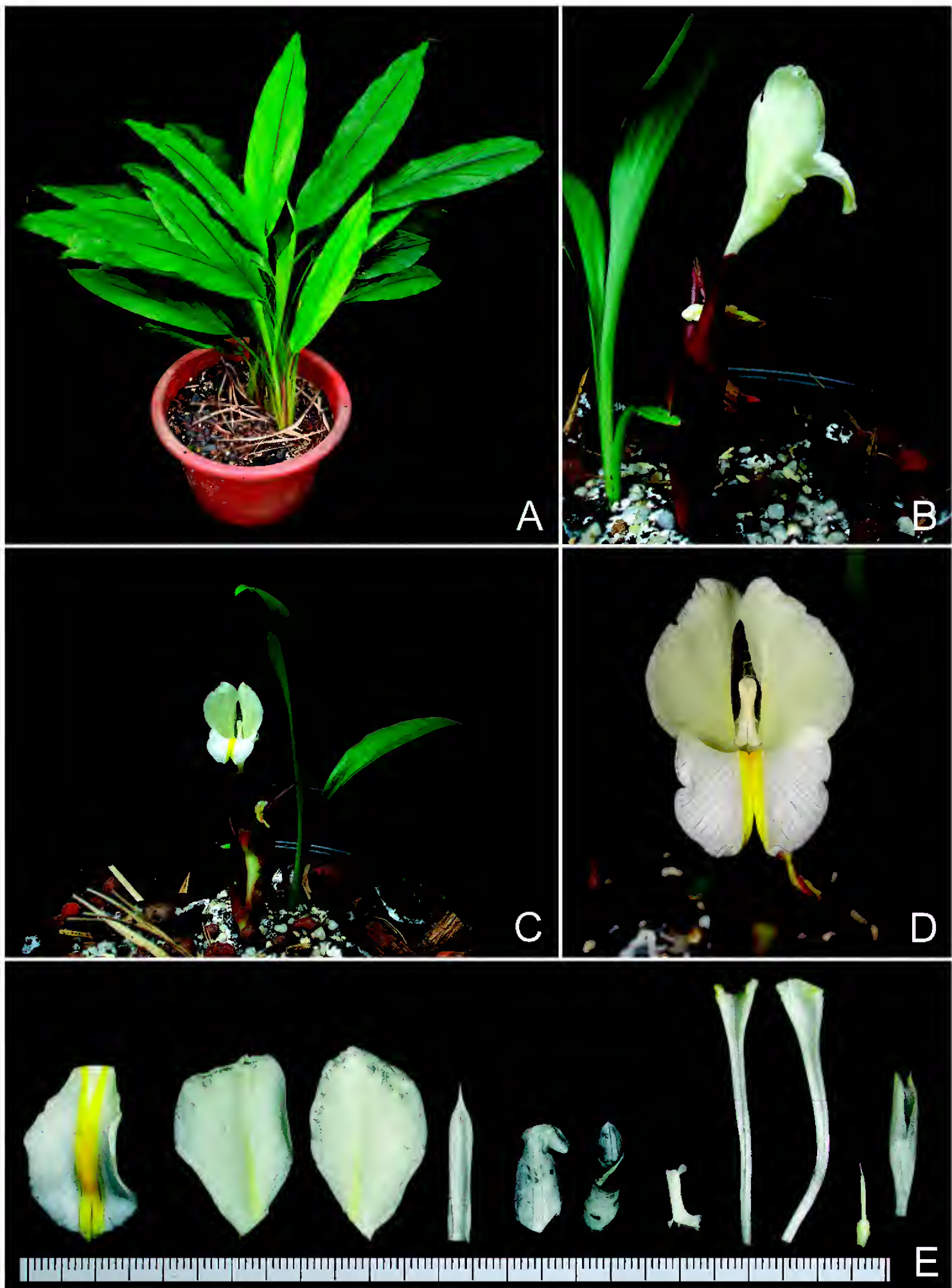


Fig. 1. *Curcuma newmanii* A. Habit (after flowering, late stage in the season). B. Inflorescence with flower (side view). C. Habit (flowering stage, beginning of the season). D. Flower (front view). E. Flower dissection (from left): Labellum, two lateral staminodes, dorsal corolla lobe, two lateral corolla lobes, anther in side view, floral tube dissected, ovary with epigynous glands, and calyx. A–E: *Trần 204*, Đắk Lắk Prov., Bản Đôn village, from cultivation. (Photos: J. Leong-Škorníčková)

anther crest not obvious; *anther thecae* 7–8 mm, dehiscing along the entire length. *Epigynous glands* two, c. 5–7 mm long, c. 0.5 mm in diam, cream-white. *Style* thin, white, glabrous, placed in the groove in dorsal side of floral tube; *stigma* c. 1.5 mm long, 1.75 mm wide, white; *ostiole* shortly ciliate, facing forward. *Ovary* 4 × 2 mm, trilocular, densely puberulent. *Fruit* not seen.

Habitat. Grows in lowland, deciduous dipterocarp forests.

Phenology. The inflorescences appear and the first flowers open from April to May, just before the leaves, with leafy shoots appearing shortly after.

Distribution. So far known only from southern Vietnam, Đắk Lắk Province, in the vicinity of Bản Đôn village.

Etymology. Named after Dr. Mark Fleming Newman, a ginger specialist from the Royal Botanic Garden Edinburgh.

Other specimens examined: VIETNAM. **Đắk Lắk.** Bản Đôn village, 12°54'37.0" N 107°50'19.3"E, 223 m, 25 June 2008, *Trần et al.* s.n. (collected from cultivation, 21 May 2009, *JLS* 365) (SING incl. spirit); ibidem, 12°55'11.07"N 107°49'16.32"E, 205 m, 27 April 2010, *Trần* 204 (collected from cultivation 25 April 2013, *GRC* 142) (SING incl. spirit).

Notes: *Curcuma newmanii* has a unique anther shape (Fig. 5A) by which it is readily recognised from the otherwise similar *C. singularis* (fig. 5B). This species was discovered in the vicinity of Buôn Ma Thuột during the Sud Expert Plantes (SEP 350) expedition led by Dr. Mark Newman in June 2008. At that time, the plant was past its flowering stage and its identity could not be confirmed from old sterile inflorescences. Only after this particular collection flowered in cultivation, did it become clear that it represents a new taxon. The species has been re-collected from the same locality in April 2010 by the second author.

While *C. singularis* seems to be a widespread species occurring from Thailand through Cambodia and Laos to Vietnam, *C. newmanii* is so far known only from the type locality.

***Curcuma xanthella* Škorničk., sp. nov.**

Similar to *Curcuma flaviflora* S.Q.Tong, but differs by thinner and prominently plicate leaf blades with rounded to cordate base and longer, more prominent lateral staminodes. TYPE: *Lý* 348, Vietnam, Bình Thuận Prov., Hàm Thuận Nam Distr., Tà Káu Nature Reserve, alt. 145 m, 10°48'51"N 107°54'45"E, 11 June 2009 (holo SING; iso E, VNM). Fig. 2 & 3.

Small rhizomatous herb to 0.6 m tall. *Rhizome* ovoid, c. 1.5–3 × 1–2 cm, with thin branches (c. 3–6 mm in diam.), light brown externally, light yellow internally, slightly

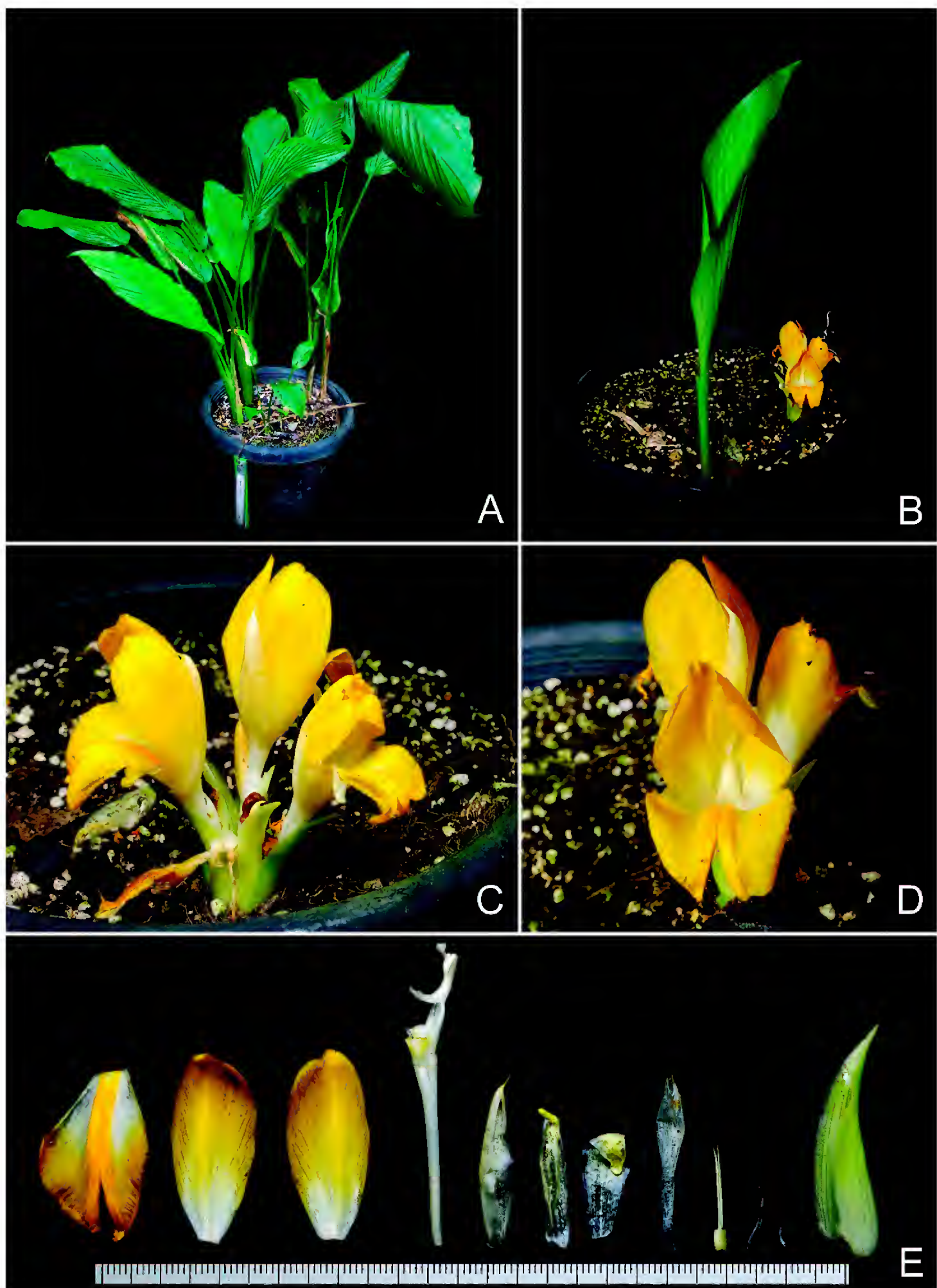


Fig. 2. *Curcuma xanthella* **A.** Habit (after flowering, late stage in the season). **B.** Habit (flowering stage, beginning of the season). **C.** Inflorescence with flowers in side and back view. **D.** Flower (front view). **E.** Flower dissection (from left): Labellum, two lateral staminodes, floral tube with stamen in side view, dorsal corolla lobe, two lateral corolla lobes, calyx, ovary with epigynous glands, bracteoles (two sizes), and fertile bract. A–E: *Trần et al. s.n.*, Bảo Lộc Pass, from cultivation. (Photos: J. Leong-Škorníková)



Fig. 3. Water colour painting of *Curcuma xanthella* at the Paris Herbarium library. (Photo: J. Leong-Škorničková)

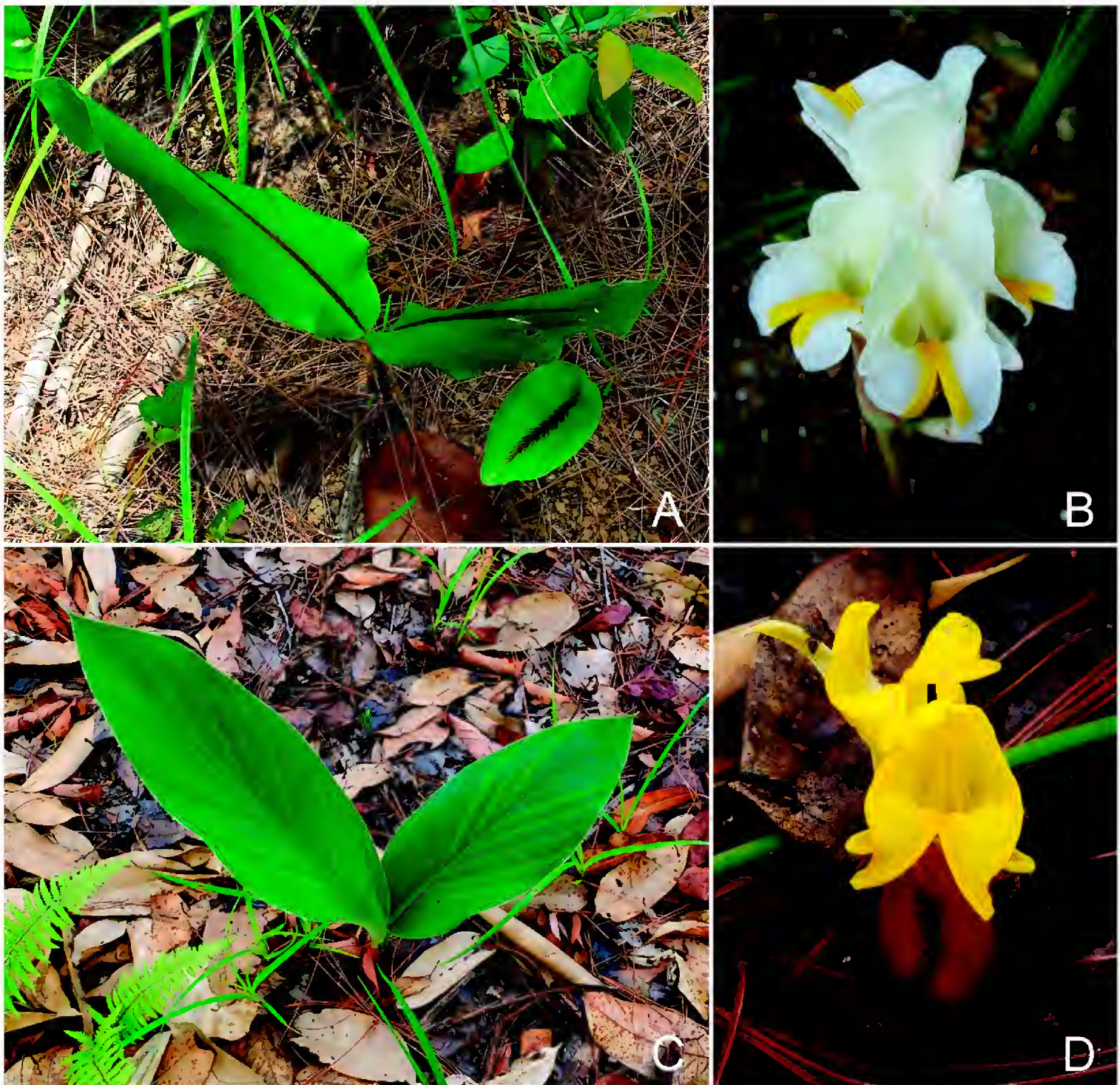


Fig. 4. Two closest allies from the subgenus *Hitcheniopsis*. **A & B.** *Curcuma singularis* (Newman et al. MFN 2413, Cambodia). **C & D.** *C. flaviflora* (Leong-Škorničková & Suksathan JLS 2220, N. Thailand). (Photos: J. Leong-Škorničková)

aromatic with bitter almond-like scent, bitter to taste; *root tubers* elliptic, 2–3 cm long, light brown externally, cream white internally, developing some distance from the rhizome. **Leafy shoot** with 3–6 leaves, developing at the same time or shortly after flowering; *pseudostem* to 15(–30) cm long, green, composed of sheathing bracts and leaf sheaths; *sheathing bracts* 1–3, tinged with light purple when young, fast drying out and decaying; *leaf sheaths* green, glabrous; *ligule* up to 3 mm long, bilobed, hyaline, greenish white, translucent, glabrous; *petiole* up to 23 cm long (petiole of outermost leaf shortest, innermost leaves longest), canaliculate, green, glabrous; *lamina* slightly unequal, elliptic lanceolate (fide Lindley), to 32×9.5 cm, prominently plicate, adaxially bright green, glabrous, abaxially lighter green, glabrous; midrib green, glabrous on both sides; base rounded to cordate; apex acuminate, puberulent.



Fig. 5. Comparison of anthers of the two newly described species and their closest allies. **A.** *C. newmanii* (Trần 204, Vietnam). **B.** *C. singularis* (Newman et al. MFN 2413, Cambodia). **C.** *C. xanthella* (Trần et al. s.n., Vietnam). **D.** *C. flaviflora* (Leong-Škorničková & Suksathan JLS 2220, N. Thailand). (Photos: J. Leong-Škorničková)

Inflorescence lateral, peduncle and often also base of the spike subterranean; *peduncle* to c. 15 cm long, to 6 mm diam., cream-white, with up to 5 sheathing bracts; *spike* 4–5 cm long, c. 1.5–2 cm diam. in the middle, wider apically, coma absent; *fertile bracts* 4–8 per inflorescence, bract 4.5×2.1 cm (larger at the base of the inflorescence), ovate to narrowly ovate, smaller and ovate at the apex, whitish at base to light green or with varying degree of deep rusty-red to purple at apices, both sides puberulent, connate in the lower 1/4, apex narrowly acute, reflexed; *cincinni* with 2 flowers at the base of the inflorescence, 1 flower at the top; *bracteoles* one per flower, narrowly triangular, $2-8 \times 1-1.5$ mm (outer ones larger, inner ones are gradually smaller), hyaline, translucent white, glabrous, but shortly hairy on apex. **Flower** c. 7.5 cm long, much exserted from the bracts, *calyx* up to 30 mm long, 3-toothed, with unilateral incision c. 11 mm, translucent white, sparsely puberulous; *floral tube* c. 3.5 cm long, externally white and almost glabrous in the basal part, yellowish and shortly densely hairy internally and externally in the apical part (upper 2/3), with dorsal groove holding the style; *dorsal corolla lobe* $30-34 \times 10-12$ mm, triangular ovate, concave, glabrous, whitish at base, yellowish towards the apex, apex mucronate, mucro 2–3 mm long, sometimes with a few short hairs; *lateral corolla lobes* $27-28 \times 9-10$ mm, triangular ovate, concave, glabrous, whitish at base, yellowish towards the apex; *labellum* $32-35 \times 22-25$ mm, obovate, apex emarginate, incision to 12 mm, base of the labellum white to light yellow, middle and apical part warm yellow, with two yellow-orange swollen bars running across the centre (forming a median band), densely puberulent with glandular hairs; *lateral staminodes* c. $32-35 \times 15-16$ mm, irregularly oblong, bright warm yellow with short glandular hairs on the adaxial side. **Stamen** 12–13 mm long; *filament* 4–9 mm long, cream white, c. 4 mm broad at base, 2–2.5 mm broad at apex (the point of attachment to the connective), covered with short, glandular hairs; *anther* c. 8–9 mm long (measured in side view with spurs unmanipulated), spurred; *connective* cream white, densely covered with short glandular hairs; *anther spurs* c. 6 mm long, narrowly acute, pointing outwards (making the anther appear as L-shaped); *anther crest* not obvious; *anther thecae* 3–4 mm, heart-shaped, placed apically, dehiscing along the entire length. **Epigynous glands** two, c. 15 mm long, 0.5–0.75 mm in diam., cream-white. **Style** thin, white, glabrous, placed in the groove in dorsal side of floral tube; *stigma* c. 1.5 mm long, 1.75 mm wide, white; *ostiole* ciliate, facing forward. **Ovary** 4×2.5 mm, trilocular, densely puberulent. **Fruit** a globular trilocular capsule, c. 1–1.5 cm in diam., white, puberulent; *seeds* irregularly obovoid, c. 4 mm long, light brown, shiny, enclosed in a translucent white, laciniated aril.

Habitat. Occurs in mixed broad-leaved semi-deciduous forests (Tà Kóu Nature Reserve) as well as in evergreen mountain forest (Bảo Lộc Pass).

Phenology. Flowering starts by end of April and continues throughout May and June, fruiting occurs at the end of May and in June and likely continues until July.

Distribution. So far recorded from two places in southern Vietnam, in Bình Thuận province, Tà Kóu mountain, and Lâm Đồng Province, Bảo Lộc pass. The distance between the two localities is about 80 km. The plants growing in Bảo Lộc at a higher elevation (c. 550 m) exhibit narrower leaves compared to those from lowland in Tà Kóu (c. 150 m), but there are no obvious differences in floral features.

Etymology: The specific epithet derived from the Greek refers to the yellow colour of the flowers.

Other specimens examined: Vietnam, **Bình Thuận Prov.:** Tà Kóu mountain, 30 May 2009, Nguyễn Thiện Tịch (under Trần collection number), *Trần-158* (E, SING, incl. spirit). **Lâm Đồng Prov.:** Bảo Lộc Pass, 22 June 2008, *Trần et al.* s.n. (collected from cultivation, 6 May 2013), *GRC-147* (SING, incl. spirit)

Notes: With its spike composed of a few bracts, yellow flowers and L-shaped anthers, *C. xanthella* is somewhat similar to *C. flaviflora*, but *C. flaviflora* is a high-elevation species known to occur in Pine forests in mountains of northern Thailand and southern China and differs from *C. xanthella* by the fairly leathery leaves with no prominent plication, and different shape and proportions of various flower parts. Especially, the staminodes are particularly large and prominent in *C. xanthella* (compare Fig. 2 and 4 C, D). The shape of the anther is also different (compare Fig. 5C and 5D).

It is also similar to *C. singularis* in that the flowers are well-exserted from the bracts and the L-shaped anthers, but *C. xanthella* differs by its yellow flowers (vs. pure white flowers with yellow median band) and bright green, thin, plicate leaf blades with a rounded to cordate base (vs. thicker, dull, darker leaf blades with no prominent plication and an attenuate to obtuse base) and longer, more prominent lateral staminodes. The anther thecae in *C. xanthella* are short, almost heart-shaped and positioned at the top, while those in *C. singularis* are much longer (compare Fig. 5B and 5C). While the occurrence of white and yellow variation of flower parts of staminodial origin (labellum, lateral staminodes and anthers) within a single species (and within same population) has been previously reported from India for certain species in the subgenus *Curcuma*, e.g., *C. kannanorensis* R. Ansari, V.J. Nair & N.C. Nair (Leong-Škorničková et al. 2010a), it has so far not been observed in members of the subgenus *Ecomata*.

Curcuma xanthella was first discovered a century ago by A. Krempf and painted by Truong Ngoc Giu; the colour painting is found in the Icon collection of the Paris Herbarium Library (Fig. 3). On the reverse side of this painting the date is given as 18 June 1908, however it is not clear if this date refers to the date of plant collection or the date of presentation of the painting to the Library. There is no locality given, but it is likely to be southern Vietnam as Krempf is known to have collected in Annam. We have encountered this species several times around the Bảo Lộc pass area during the Sud Expert Plantes (SEP 350) expedition. However the plants were not flowering at the time. Subsequently, our collections have repeatedly flowered in cultivation since

2009, but also new collections have been made in the Tà Kóu Nature Reserve around the same time by Mr. Lý Ngọc Sâm and by Mr. Nguyễn Thiện Tịch and Dr. Lưu Hồng Trường (SGN); all of them have provided us with additional photographs or herbarium specimens. We have chosen the most complete collection *Lý 348* as the type.

The colour of the bracts in *C. xanthella* may be light green (as seen in Fig 2C) or cream with various degrees of purple red tinge (as seen in Fig 3).

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A new species of *Somrania* (Gesneriaceae) from Thailand

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ABSTRACT. The new species *Somrania flavida* D.J.Middleton & Triboun, from Khao Sok National Park in Surat Thani Province, Thailand, is described. It is the third species in this genus which is restricted to karst limestone habitats in Thailand. A key to the species of *Somrania* is provided.

Keywords. New species, *Somrania*, Thailand

Introduction

The genus *Somrania* D.J.Middleton was originally described from karst limestone habitats in southern Thailand with two new species, *Somrania albiflora* D.J.Middleton and *S. lineata* D.J.Middleton & Triboun (Middleton & Triboun 2012). Its distinctive characters are branched hairs, tubular corolla, a stigma with only the lower lobe developed and bifid, and short straight fruit. From DNA sequence data it is most closely related to *Damrongia* Kerr ex Craib (Puglisi, pers. comm.) in the “*Boea* group” sensu Möller et al. (2009).

At the time of publication we were aware that there may be a third species from Khao Sok National Park but the available material was inadequate to describe it. Plants grown from seed collected at Khao Sok in 2008 have now flowered at the Royal Botanic Garden Edinburgh and we have been able to confirm that it is indeed a new species of *Somrania*.

The new species is described below and a key to the species of *Somrania* is provided.

Key to the species of *Somrania*

- 1a. Corolla c. 13.5 mm long, white throughout with no coloured lines inside tube
..... *S. albiflora*
- 1b. Corolla 15–18 mm long, with orange-brown or yellowish markings on ventral
surface inside corolla tube 2

- 2a. Corolla with sharp orange-brown lines on ventral surface inside corolla tube; branched hairs on leaves but not on inflorescence axes; petioles 3–10.2 cm long ..
..... *S. lineata*
- 2b. Corolla with diffuse yellowish lines on ventral surface inside corolla tube; branched hairs present on leaves and inflorescence axes; petioles 1–3 cm long
..... *S. flavida*

***Somrania flavida* D.J.Middleton & Triboun, sp. nov.**

Differs from *Somrania albiflora* in the diffuse yellowish lines on the ventral surface of the inside of the corolla (white throughout in *Somrania albiflora*), and the denser hair covering on the upper surface of the leaves. Differs from *Somrania lineata* in the diffuse lines on the ventral surface of the inside of the corolla (two sharp lines in *Somrania lineata*), shorter petioles, and in the presence of branched hairs on the inflorescence (inflorescence hairs unbranched in *Somrania lineata*).

TYPE: *Middleton 5297*, cultivated at Royal Botanic Garden Edinburgh, Scotland, 1 Oct 2013 (holo E). Originally from Thailand, Surat Thani, Ban Thakhun District, Khao Sok National Park, edge of the lake, 100 m alt., 6 Sep 2008, *Middleton, Triboun, Chamchumroon, Saengrit & Simma 4324*, cultivated as RBGE 20081567. Fig. 1.

Herb, acaulescent or forming a short stem to 1.5 cm long at flowering. **Leaves:** petioles 1–3 cm long, densely covered in branched hairs and sessile glands; lamina broadly elliptic to orbicular, $1.1\text{--}12.2 \times 0.8\text{--}8.4$ cm, 1.2–1.5 times as long as wide, apex rounded, base rounded to subcordate, slightly unequal or not, margin crenate, with 4–6 pairs of steeply ascending secondary veins, densely covered in a mixture of unbranched slightly curved eglandular hairs and with occasional sessile or shortly stalked gland-tipped hairs above, densely covered with branched hairs and sessile glands beneath. **Inflorescence** 12–13-flowered, densely pubescent with a mixture of eglandular branched hairs (but see note below) and short gland-tipped hairs throughout; bracts narrowly ovate, pubescent as on calyx; $2\text{--}4 \times 0.5\text{--}0.9$ mm, peduncle 7.5–9.5 cm long; pedicels 3–8 mm long. **Calyx** of 5 lobes almost free to base (fused for < 0.5 mm); lobes narrowly triangular, c. 4.4×0.9 mm, apex acute, densely pubescent outside with a mixture of eglandular branched hairs, shorter eglandular hairs and short gland-tipped hairs, inside with sessile glands. **Corolla** white throughout except with 2 broad and diffuse yellow bands from sinuses of lower lip down into tube, fainter yellow spots at other 3 sinuses, mouth slightly oblique, limb 2-lipped, 15–17 mm long; tube c. 12 mm long, outside with a mixture of eglandular branched hairs, simple eglandular hairs and gland-tipped hairs, inside glabrous; lower lip c. 5 mm long, upper lip c. 3.5 mm long; upper lobes orbicular, c. 3.5×4 mm, apices rounded; lateral lobes orbicular, c. 3.6×4 mm, apex rounded; lower lobe orbicular, c. 3.8×4.5 mm, apex rounded. **Stamens** 2, anterior, white throughout, inserted at 2.5 mm from corolla base which is 21% of tube length; filaments straight, c. 4 mm long, glabrous; anthers oriented with locules upwards and downwards in tube, fused by the apices and touching face to face, 0.7×1.7 mm; 2 lateral staminodes c. 1.5 mm long, geniculate, medial staminode c. 1 mm long, straight. **Disc** 0.7 mm long, a simple annular ring. **Pistil** c. 12 mm long; ovary



Fig. 1. *Somrania flavida* D.J.Middleton & Triboun. Inflorescence showing diffuse yellow bands in corolla. Inset: corolla side view. (Photos: D.J. Middleton)

c. 3.5 mm long, pinkish, with a mixture of unbranched eglandular hairs and shorter to subsessile gland-tipped hairs; style c. 8.5 mm long, white, with a mixture of unbranched eglandular hairs and shorter gland-tipped hairs; only lower lobe of stigma developing, bifid, lobes c. 0.7 mm long. **Fruit** a plagiocarpic capsule, narrowly fusiform, c. 8 mm long. **Seed** ellipsoid, apiculate at each end, c. 4×2 mm, surface reticulate.

Distribution. Only known from Khao Sok National Park in Surat Thani Province, Thailand.

Ecology. In partial shade on limestone cliffs at low altitude.

Etymology. The name refers to the yellowish throat of the corolla tube.

Provisional IUCN Conservation Assessment. Least Concern (LC). Although this species is known from very few collections and the size of the population is unknown it was collected from a limestone site in Khao Sok National Park. It occurs on inaccessible cliffs, not prone to human disturbance, and the National Park status will prevent exploitation of the limestone for the construction and chemical industry.

Additional specimen studied. Middleton, Triboun, Chamchumroon, Saengrit & Simma 4324, Thailand, Surat Thani, Ban Thakhun District, Khao Sok National Park, 100 m alt., 6 Sep 2008 (BKF, E).

Note. *Middleton et al.* 4324 is the parent plant from which seeds were taken to grow the plants later vouchered as *Middleton* 5297, the type specimen. The branched hairs are very much more obvious in the live plants than they are in dried plants so care should be taken when studying material.

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***Didymocarpus* (Gesneriaceae) in Thailand**

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ABSTRACT. A taxonomic revision of *Didymocarpus* (Gesneriaceae) in Thailand has resulted in eighteen species. Three new species are described: *Didymocarpus inflatus* J.F.Maxwell & Nangngam, *D. jaesonensis* Nangngam & J.F.Maxwell, and *D. payapensis* Nangngam & J.F.Maxwell. A key to the Thai species, detailed descriptions, and notes on distribution, ecology, phenology, salient morphological traits, and illustrations are presented.

Keywords. *Didymocarpus*, Gesneriaceae, taxonomic revision, Thailand

Introduction

Until relatively recently *Didymocarpus* Wall. was a large genus with approximately 180 species (Wang et al. 1998). However, Weber & Burt (1997) split *Didymocarpus* into three genera: *Didymocarpus* s.s., *Henckelia* Spreng., and *Hovanella* A.Weber & B.L.Burt. *Didymocarpus* was left with about 70 species after the removal of the Madagascan, southern Indian and Sri Lankan, and most Malesian species. The geographical range of *Didymocarpus* is from northwest India, eastwards through Nepal, Bhutan, northeast India, Burma (Myanmar), to southern China, Vietnam, Laos, Cambodia, Thailand, and the Malay Peninsula, with one species, *D. cordatus* Wall. ex DC., reaching northern Sumatra (Weber & Burt 1997).

Didymocarpus has been divided into two sections, (1) the entirely Malesian *Didymocarpus* sect. *Elati* Ridl., including *D. corchorifolius* Wall. ex DC., *D. antirrhinoides* A.Weber, *D. sulphureus* Ridl., and *D. robustus* Ridl.; and (2) *Didymocarpus* sect. *Didymocarpus* including all species not in *Didymocarpus* sect. *Elati*, i.e., most of the genus (Weber & Burt 1997). The distinction between the two sections is not very satisfactory, especially for *D. citrinus* D.Don and *D. cordatus* Wall. ex DC. from *Didymocarpus* section *Didymocarpus*, species which are rather similar to those in *Didymocarpus* section *Elati*. The results of molecular phylogenetic studies and character evolution in *Didymocarpus* from Thailand show that *D. citrinus* D.Don is in the same clade as *D. corchorifolius* Wall. ex DC. and *D. antirrhinoides* A.Weber with 100 % bootstrap support (Palee et al. 2006). As the infrageneric classification of *Didymocarpus* requires further research we do not attempt to place the species from Thailand into the existing structure.

Ten species of *Didymocarpus* were published in the *Flore Générale de l'Indo-Chine*, six of them occurring in Thailand (Pellegrin 1930). An additional species, *Didymocarpus bonii* Pellegr. is now recognised as *Petrocodon bonii* (Pellegr.) A. Weber & Mich. Möller (Weber et al. 2011). Surprisingly, none of the 31 species found in China are also found in Thailand (Wang et al. 1998).

Twenty three species of Thai *Didymocarpus* were listed by Barnett (1962a), fourteen of which still belong in *Didymocarpus*, although sometimes now in the synonymy of other taxa. One species, *D. venosus* Barnett, is the type species of the new genus *Tribounia* (Middleton & Möller 2012).

Materials and Methods

Herbarium specimens were examined from ABD, BCU, BK, BKF, CAL, CMU, E, K, L, PSU, QBG and SING (herbarium abbreviations from Thiers (2012)). Other specimens were collected from field surveys and deposited in the CMU Herbarium. Extra flowers and fruits were preserved in 70% ethanol for morphological, palynological, and taxonomic studies. Pollen and seeds of some species were investigated by scanning electron microscopy and viewed with a JEOL JSM-840 SEM system at 15-20 kV.

Didymocarpus Wall.

Didymocarpus Wall., Edinburgh Philos. J. 1: 378 (1819); Don, Prodr. Fl. Nepal. 121 (1825); Clarke in Hooker, Fl. Brit. India 4: 345 (1884); Pellegrin, Fl. Indo-Chine 4(5): 518 (1930); Barnett, Fl. Siam. 3: 211 (1962); Wang et al., Fl. China 18: 349 (1998); Weber & Burt, Beitr. Biol. Pflanzen 70: 333 (1997); Weber et al., Ann. Naturhist. Mus. Wien, B 102: 448 (2000); Burt, Thai For. Bull., Bot. 29: 91 (2001). TYPE SPECIES: *Didymocarpus primulifolius* D. Don

Deciduous perennials, terrestrial or epilithic, often succulent herbs (no shrubs in Thailand). Stems erect, glabrous or pubescent, with few nodes; new vegetative buds produced from the rhizome during the dry season which then develop during the rainy season. Leaves opposite and distichous, less commonly ternate, simple, few to many, usually in unequal pairs (anisophyllous), sometimes isophyllous, new vegetative leaves slightly whorled or tufted in close pairs; exstipulate. Leaf blades mostly subcoriaceous; asymmetrically ovate, lanceolate, elliptic-oblong, oblong, obovate, or orbicular; apex rounded, obtuse or acute; bases obliquely acute or rounded to shallowly cordate; margins variously serrate-dentate; upper surface sparsely to densely sericeous with multicellular hairs, rarely nearly glabrous; lower surface glabrous or pilose, sparsely covered with multicellular eglandular hairs; pigment glands, if present, usually on the undersurface or sparsely so on other organs. Inflorescence cymose, with few to many flowers. Bracts free, paired, ovate, apex rounded; bases broad, margin entire, caducous to persistent. Calyx mostly regular, less commonly irregular; tubular

and free to the base or variously connate, 5-lobed, glabrous or covered with multicellular glandular hairs. Corolla thin, salverform, campanulate or personate; limb bilabiate, 5-lobed, lobes usually rounded; posterior (upper) lip 2-lobed, anterior (lower) lip 3-lobed; glabrous or covered with multicellular glandular hairs. Fertile stamens 2, anterior; anthers coherent, oblong, bilocular, dorsifixed, glabrous or sometimes with white moniliform hairs, villous; locules dehiscing longitudinally; filaments inserted on inside of corolla tube, slender, alternipetalous, glabrous or covered with glandular hairs on the upper part. Staminodes 2–3, posterior, alternipetalous, reduced to minute filaments of unequal length. Pollen spheroidal, tricolpate with long apertures or narrowly elliptic with pointed ends; sculpturing microreticulate, microreticulate-scabrate and rugulate; 10–15 μm diameter. Disc cylindric or cupular, irregularly and shallowly lobed, glabrous, usually persistent on the capsule. Ovary superior, stipitate, cylindrical, glabrous or with multicellular glandular hairs, 2-locular, with parietal placentation and numerous ovules; style well-developed, glabrous or with glandular hairs; stigma one, capitate or concave. Capsules straight in relation to the pedicel, stipitate, bivalved, dehiscing loculicidally. Seeds numerous, unappendaged; elliptic to reniform; testa reticulate, cell ornamentation straight, cell faces smooth, verrucate, or tuberculate. Basic chromosome numbers $x = 11, 12, 14, 16$, and 18 .

Distribution. About 70 species in North-West India, southern China, South-East Asia and northern Sumatra including 18 species in Thailand.

Habitat and ecology. *Didymocarpus* species are usually found in shaded and moist areas, terrestrial, on trees and on various bedrocks. Most species are found between 500–1800 m elevation in primary forests such as mixed evergreen with pine forest and deciduous dipterocarp-oak seasonal hardwood forest, distributed throughout Thailand.

Habit. Thai *Didymocarpus* species are perennial herbs usually growing in seasonally moist rocky places. The stems are succulent and somewhat lignified in some species (*D. corchorifolius* Wall. ex DC.), usually curved at base, if erect often with many nodes, up to 1.5 m tall.

Key to Thai *Didymocarpus* species

- 1a. Calyx formed into a tube at base with all calyx lobes less than half the length of the calyx 2
- b. Calyx with lobes free to the base (i.e., at least 2 sepals free) or with a short calyx tube and the lobes more than half the length of the calyx 9
- 2a. Corolla salverform, tube geniculate or straight 3
- b. Corolla funnelform, tube gradually widening from the base to the throat 5

- 3a. Corolla ≥ 3 cm long (East-Central Thailand) 6. *D. epithemoides*
- b. Corolla ≤ 2.5 cm (North Thailand) 4

- 4a. Corolla tube geniculate, dark violet, lobes whitish or pale green, anthers glabrous
..... 11. *D. kerrii*
- b. Corolla tube straight, purplish-whitish, lobes purplish, anthers white-bearded
..... 16. *D. purpureopictus*

- 5a. Corolla ≤ 3.5 cm long, crimson or violet 6
- b. Corolla at least 4 cm long or more, of other colours 7

- 6a. Corolla c. 3 cm long, violet; corolla, ovary and anthers glabrous (North Thailand)
..... 10. *D. jaesonensis*
- b. Corolla c. 3.5 cm long, crimson-red; corolla and ovary covered with
multicellular glandular hairs; anthers white-bearded (South Thailand)
..... 12. *D. megaphyllus*

- 7a. Corolla 6–7 cm long, deep maroon-red, paler at anthesis, ovary with pigment
glands; leaves with pigment glands; capsule 6 cm long 18. *D. wattianus*
- b. Corolla < 5 cm long, violet or whitish; ovary glabrous; leaves without pigment
glands; capsule 5.5 cm long 8

- 8a. Bracts and calyx not inflated, green-maroon to purple without pinkish hue; calyx
asymmetrically campanulate with tube < 1.5 cm long; corolla dark violet with
white lines extending to the base of the anterior lip; anthers white-bearded; fila-
ments straight, glabrous 3. *D. biserratus*
- b. Bracts and calyx appearing inflated, dull light violet to white with a faint pinkish
hue; calyx campanulate with tube c. 1.5 cm long; corolla tube pale violet to whit-
ish, lobes reddish; anthers glabrous; filaments flexed at the middle, upper part
pubescent 8. *D. inflatus*

- 9a. Corolla white or pale pinkish 10
- b. Corolla purple, violet, or distinctly reddish 13

- 10a. Corolla funnelform 11
- b. Corolla campanulate, personate 12

- 11a. Corolla 3 cm long, with violet or maroon streaks, ovary pubescent (North Thai-
land) 1. *D. aureoglandulosus*
- b. Corolla 1.5 cm long, without streaks, ovary glabrous (Northeast Thailand)
..... 5. *D. dongrakensis*

- 12a. Corolla personate, whitish, with yellow streaks below each sinus of the anterior
lip (Peninsula) 4. *D. corchorifolius*

- b. Corolla campanulate, white, without streaks 13. *D. newmanii*
- 13a. Corolla funnelform 14
 - b. Corolla salverform 15
- 14a. Calyx irregular, upper lip composed of 2 free lobes, lower lip connate at base, 3-lobed at apex, leaves opposite (Ranong) 7 *D. geesinkianus*
 - b. Calyx regular, free, 5-lobed to the base, leaves ternate (Northeast Thailand) 9. *D. insulsus*
- 15a. Corolla bicolorous with tube reddish and lobes pale green or whitish (Loei) 2. *D. bicolor*
 - b. Plant not as above 16
- 16a. Calyx campanulate, lobed c. 2/3 to the base, pubescent (North Thailand) 15. *D. payapensis*
 - b. Calyx free, 5-lobed to the base, glabrous (Southeast & Southern Thailand) ... 17
- 17a. Leaves opposite, anisophyllous; pigment glands absent, anthers white-bearded (Southern Thailand) 14. *D. ovatus*
 - b. Leaves ternate or 3-pseudoverticillate; red-brown pigment glands present; anthers glabrous (Chanthaburi) 17. *D. tristis*

An enumeration of the species follows. Appendix A gives an identification list of specimens examined, and Appendix B lists accepted and new species names, as well as synonyms.

1. *Didymocarpus aureoglandulosus* C.B.Clarke

Repert. Spec. Nov. Regni Veg. 4: 292 (1907) (as *aureo-glandulosa*); Hosseus, Beih. Bot. Centralbl. 28(2): 439 (1911) (*aureo-glandulosa*); Craib, Bull. Misc. Inform. Kew 1911: 431 (1911); Craib, Aberdeen Univ. Stud. 57: 149 (1912) (*aureo-glandulosa*); Pellegrin, Fl. Indo-Chine 4(5): 525 (1930) (*aureo-glandulosus*); Barnett, Dansk Bot. Ark. 20(2): 202 (1962); Barnett, Fl. Siam. 3(3): 211 (1962); Hilliard & Burt, Edinburgh J. Bot. 52(2): 215 (1995); Weber & Burt, Beitr. Biol. Pflanzen 70: 308 (1997); Weber et al., Ann. Naturhist. Mus. Wien, B 102: 453 (2000); Burt, Thai For. Bull., Bot. 29: 91 (2001). TYPE: *Hosseus* 220, Thailand, Chiang Mai, Doi Sutep [Doi Suthep], 1650 m, 23 Dec 1904 (holotype K; isotypes BM, E, M, P). Fig. 1A.

Didymocarpus rodgeri W.W.Sm. & S.C.Banerji, Rec. Bot. Surv. India 6(2): 42 (1913). TYPE: *Roger* 161, Burma, Ruby Mines Div., Mogok, 4000 ft (lectotype CAL, designated by Hilliard & Burt (1995); isotype K).

Didymocarpus rodgeri var. *siamensis* W.W.Sm. & S.C.Banerji, Rec. Bot. Surv. India 6(2): 43 (1913). TYPE: *Kerr 1996*, Thailand, Doi Sootep [Suthep], 5200 ft, 27 Aug 1911 (lectotype CAL, designated here; isotypes BM, E).

Deciduous, epiphytic, perennial herb, less commonly epilithic, up to 33 cm tall. **Rhizome** erect to ascending, 1–2 cm long, c. 5–7 mm thick. **Stems** erect, light green to dark maroon, sparsely to densely sericeous, with peltate, red-brown pigment glands and multicellular glandular hairs. **Dry season leaves** dormant from November–May; blades subcoriaceous, light green, symmetrically ovate, 1.5–3.8 cm long, 2.8–6.5 cm wide, apex obtuse, base acute to truncate, margins shallowly serrate, upper surface densely sericeous with silvery-green/grey multicellular eglandular hairs, lower surface sparsely strigose on the main veins, less so otherwise, densely covered with minute, one-celled, red-brown, peltate, sessile pigment glands, midrib with 6–8 ascending pinnate secondary veins on each side, sunken above, raised underneath, finer venation invisible; petioles terete, 1.3–2 cm long, sparsely sericeous and densely covered with red-brown, pigment glands as on the blades underneath. **Rainy season leaves** developing from the dormant ones at the beginning of the rainy season (June–August) and continuing growth until after fruiting in September when they abscise; blades subcoriaceous, asymmetrically oblong to elliptic, upper surface dark green, 9–23 cm long, 6–14 cm wide, apex rounded to obtuse, base obliquely rounded on one side, acute on the other, margins shallowly and coarsely doubly serrate, upper surface moderately strigose with multicellular eglandular hairs, epidermis visible, lower surface main veins sparsely covered with multicellular eglandular hairs, scattered one-celled, pigment glands, midrib with 6–8 ascending pinnate secondary veins on each side, sunken above, raised underneath; petioles terete, 2–9 cm long, sparsely velutinous with multicellular eglandular hairs, dorsally maroon, ventrally light green. **Inflorescences** arising from among the leaves, axillary, erect, laxly cymose, 10–20 cm long, axes sparsely velutinous with multicellular glandular hairs, peduncle pale brown, other axes pinkish-light green; peduncle 10–16 cm long; pedicels 0.5–1.8 cm long. **Bracts** slightly asymmetric, thin, lanceolate, 3–5 mm long, 1–1.5 mm wide, densely covered with multicellular glandular hairs as on the peduncle. **Flowers** several, c. 3 cm long. **Calyx** 5-lobed to the base, lobes symmetrically linear-lanceolate, 9–12 mm long, 2 mm wide, tips acute, outside sparsely covered with multicellular glandular hairs as on bracts, light green-whitish. **Corolla** funnelform, 3 cm long, glabrous, whitish to pale pink-whitish with pale violet or pale maroon streaks; tube 2.5 cm long; anterior (lower) lip 3-lobed, lobes orbicular, 6 × 6 mm; posterior (upper) lip 2-lobed, lobes elliptic, 6 × 3 mm. **Fertile stamens** inserted above the middle of the tube; filaments 3–5 mm long, glabrous on the lower part, upper part covered with glandular hairs, light yellow to white; staminodes 3, reduced to filaments, c. 3–5 mm long, glabrous; anther locules oblong, 2 mm long, tips and bases acute, glabrous, cream, orange or white. **Pollen** spheroidal, 11–12 µm, microreticulate; long aperture partly covered with glandular elements. **Disc** cylindric, 3 mm long, margin irregularly lobed. **Ovary** cylindrical, 10 mm long, sparsely setulose, with indumentum as on the outside of the calyx, pale pinkish; style glabrous, whitish; stigma capitate, whitish or reddish. **Capsules** erect,

symmetrically cylindric, glabrous, 2-valved, loculicidally dehiscent, 4.5 cm long, 0.2 cm wide. **Seeds** numerous, narrowly elliptic, 0.5×0.5 mm, cell orientation straight.

Distribution. Northern Thailand.

Ecology. Moist, shaded areas in primary evergreen forest, usually growing on tree trunks or in moist rocky places.

Phenology. Flowering July–September, fruiting August–December.

Vernacular name. Dok Kra Ding (ดอกกระดังง์).

Etymology. The specific epithet refers to the golden colour of the pigment glands.

Notes. *Didymocarpus aureoglandulosus* is distinct from most species found in northern Thailand in the whitish corolla while the other species have a purple to violet or reddish corolla.

Specimens examined: THAILAND. **Chiang Mai.** Doi Sutep [Suthep] Pui National Park, c. 1600 m, 17 Aug 2002, *Palee 524* (CMU); *ibid.*, 12 Nov 2002, *Palee 549* (CMU); *ibid.*, 11 Aug 1996, *BGO staff 7057* (QBG); *ibid.*, 17 Sep 2008, *Middleton et al. 4453* (E); *ibid.*, 13 Aug 2012 *Middleton et al. 5578* (E); *ibid.*, 22 Jul 1958, *Larsen & Hansen 4341* (ABD); *ibid.*, 11 Sep 1958, *Larsen & Hansen 4902* (ABD); Mae Wang District, below Pah Ngaem (limestone cliffs), c. 1700 m, 26 Aug 2004, *Palee 701* (CMU); Mae Awn District, Doi Lohn (Lahn), west side, Jae Sawn National Park, c. 1550 m, 28 Sep 2004, *Maxwell 04-526* (CMU); Jawm Tong [Chom Thong] District, near the summit of Mae Soi Ridge, Mae Soi Subdistrict, c. 1625 m, 5 Sep 1992, *Maxwell 92-496* (CMU); Doi Chiang Dao, c. 1300–1500 m, 15 Aug 1963, *Smitinand & Sleumer 1012* (E); *ibid.*, 24 Feb 2003, *Palee 570* (CMU); Mae On, Doi Lan Ranger Unit, Jae Son National Park, epiphyte on tree, c. 1500 m, *Pooma & Pattharahirantricin 7722* (E). **Nan.** Doi Phu Kha National Park, 19.0° N, 101.0° E, c. 1630 m, 30 Jul 1998, *Srisanga 251* (QBG).

2. *Didymocarpus bicolor* Craib

Bull. Misc. Inform. Kew 1926: 168 (1926); Pellegrin, Fl. Indo-Chine 4(5): 521 (1930); Barnett, Fl. Siam. 3(3): 212 (1962); Weber et al., Ann. Naturhist. Mus. Wien, B 102: 454 (2000); Burtt, Thai For. Bull., Bot. 29: 91 (2001). TYPE: *Unknown collector 83/3*, cultivated plant grown from seeds collected by Kerr from Pu Tong, Thailand, Loei, 1000–1200 m, which flowered in Aberdeen in 1924 (holotype ABD). Fig. 1B.

Deciduous, epilithic, perennial herb. **Dry season** plants unknown. **Rainy season** stem erect, simple or with a few branches, c. 50 cm tall, green, covered with multicellular eglandular hairs. *Leaves:* blades green above, pale green beneath, broadly ovate or oblong-ovate, c. 7–11 cm long, 5.5–6.5 cm wide, apex obtuse, base cuneate, slightly oblique, margins denticulate-serrate with fine hairs, upper surface sericeous, lower

surface with veins covered with multicellular eglandular hairs, pigment glands absent, midrib with 5–6 ascending pinnate secondary veins on each side, obscure above, prominent underneath; petioles 1–3 cm long, covered with multicellular eglandular hairs. **Inflorescences** cymose; peduncle c. 5.5 cm long; pedicels c. 1 cm long, glabrous or sparsely pilose, often reddish. **Bracts** free, broadly ovate, c. 6 mm long, glabrous or sparsely covered with multicellular gland-tipped hairs, apex green, base reddish. **Flowers** numerous. **Calyx** 5-lobed to the base, lobes linear-lanceolate, 3–3.5 mm long, 1–1.5 mm wide, apex obtuse, glabrous. **Corolla** salverform, 2–2.5 cm long, glabrous, tube pale reddish, lower lobes pale green or whitish, upper lobes dark violet-reddish; tube 1.5–2 cm long, basal diameter c. 4 mm; anterior (lower) lip 3-lobed, lobes oblong, c. 3–5 mm long, c. 3–4 mm wide, tips rounded-truncate; posterior (upper) lip 2-lobed, c. 2 mm long, c. 2.5 mm wide, apex rounded. **Fertile stamens** inserted in the upper part of the corolla tube; anthers with very short hairs; filaments slender, whitish, c. 4 mm long; staminodes 2, whitish, c. 1 mm long, occasionally smaller or not well-developed. **Disc** cylindric, 1.5 mm long. **Ovary** 1.8 cm long; ovary lower part reddish, upper part pale green, with scattered, glandular-capitate hairs; style glabrous, pale green; stigma capitate, papillose, green. **Capsules** erect, cylindric, green, 2 cm long, 2 mm wide. **Seeds** numerous, other details not studied.

Distribution. Endemic to Thailand. Only known from Loei province, northeast Thailand.

Ecology. Plants grow in shade, near streams with higher humidity, or on rocks in evergreen forest.

Phenology. Flowering September–November, fruiting December.

Vernacular name. Dok Song See (ดอกสองสี).

Etymology. The specific epithet refers to the two different colours in the corolla.

Notes. The distinctive character of this species is the bi-coloured corolla, of which the tube is reddish or wine-coloured while the three lower lobes are greenish or whitish.

Specimens examined: THAILAND. **Loei.** Phu Luang, 26 Nov 1957, *Dee Bunpheng* 998 (ABD); Phu Ruea National Park, along stream, 9 Sep 2009, *Nangngam* 2552 (CMU); Plants cultivated at Royal Botanic Garden Edinburgh from seeds collected from Phu Luang by T. Smitinand, flowering in 14 Oct 1986, *Accession no.* RBG 19850475 (E).

3. *Didymocarpus biserratus* Barnett

Nat. Hist. Bull. Siam Soc. 20(1): 11 (1961); Barnett, Kew Bull. 15(2): 250 (1961); Barnett, Fl. Siam. 3(3): 212 (1962); Weber et al., Ann. Naturhist. Mus. Wien, B 102:

454 (2000); Burt, Thai For. Bull., Bot. 29: 91 (2001). TYPE: *Smitinand 1870* (R.F.D 9482), Thailand, Loei, Phukrading [Phu Kradueng], c. 1300 m, 20 Aug 1954 (lectotype E, designated by Barnett in Kew. Bull. (1961); isotypes BKF, L). Fig. 1C.

Didymocarpus siamensis Barnett, Dansk Bot. Ark. 20(2): 201 (1962); Barnett, Fl. Siam. 3(3): 217 (1962). TYPE: *Larsen 6258*, Thailand, Loei, Poo Kradeng [Phu Kradueng], c. 1250 m, 27 Nov 1958 (holotype ABD; isotypes K, BKF).

Deciduous, epilithic, perennial herb. **Dry season** plants unknown. **Rainy season** stems 8–44 cm tall, sparsely and finely villous with multicellular eglandular hairs; green-maroon. **Leaves** paired, anisophyllous; blades subcoriaceous, pale green, symmetrically suborbicular to elliptic, 6–13.5 cm long, 3–8.5 cm wide, apex obtuse to bluntly acute, base rounded to cordate, margins shallowly (smaller blades) to deeply (larger ones) doubly serrate, lower surface with indumentum as on stem, pigment glands absent on both surfaces, midribs with 6–8 ascending secondary veins on each side, obscure above, prominent underneath; petioles dark green, 1.5–10 cm long, covered with an indumentum as on the stems. **Inflorescences** terminal and also often in the upper leaf axils, cymose, 7–14 cm long, axes glabrous; peduncles 5–8 cm long; pedicels 1.5–4 mm long. **Bracts** paired, thin, suborbicular, c. 7 mm long and wide, tips broadly rounded, glabrous, green-maroon to purple, in pairs below and concealing two pedicels and lower parts of the calyx. **Flowers** numerous. **Calyx** asymmetrically campanulate, glabrous, green-maroon to purple; tube 1–1.3 cm long, diameter 4 mm; lobes subequal, apices broadly rounded, anterior 2 lobes 2.5 mm long, posterior 3 lobes 1.5 mm long. **Corolla** funnelform, 4 cm long, glabrous, dark violet with 4 white lines extending to the base of the anterior lip; tube 3–3.5 cm long, basal diameter c. 3 mm, gradually widening from the base to throat; lobes elliptic, tips broadly rounded; anterior (lower) lip 3-lobed, lobes 4 mm long, 7 mm wide; posterior (upper) lip 2-lobed, slightly smaller. **Fertile stamens** inserted c. 1.8–2 cm from the base of the corolla tube; filaments 7 mm long; anthers oblong, 2 mm long, 1 mm wide, densely villous (white-bearded); filaments straight, glabrous, whitish; staminodes 3, inserted c. 1 mm below the level of the stamens, glabrous, lateral staminodes 2.5 mm long, the other one c. 1 mm long. **Disc** tubular, thickened, margin undulate, c. 1.5 mm long, persistent in fruit. **Ovary** cylindric, c. 1.2 cm long, glabrous; style continuous with the ovary, c. 4 mm long, glabrous; stigma flat, circular, thin, peltate, c. 2 mm diameter and much wider than the style, level with the middle of the anthers. **Capsules** erect, cylindric, green and maturing light brown, 4–5.5 cm long, c. 1.5 mm wide. **Seeds** elliptic, 0.4 × 0.2 mm, apex truncate, cell orientation straight, cell shape narrowly lineate-polygonate, cell edges elevated and smooth, cell crests fused, faces depressed and finely verrucate.

Distribution. Endemic to Thailand. Only known from Loei province, northeast Thailand.

Ecology. Plants grow in shade, near streams with higher humidity, or on rocks in evergreen forest.

Phenology. Flowering July–August, fruiting August–October, leaves May–October.

Vernacular name. Dok Bai Yak (ดอกใบหยัก).

Etymology. The specific epithet refers to the doubly serrate leaf margin.

Notes. *Didymocarpus biserratus* is easily recognised by the doubly serrate leaf margin. It differs from *Didymocarpus inflatus* in having smaller bracts and corollas.

Specimens examined: THAILAND. **Loei.** Phu Kradueng National Park, Wang Kwang Cave, 1125 m, 5 Oct 2003, *Palee* 639 (CMU, E); *ibid.*, 24 Aug 1948, *DE* 191 (E); *ibid.* 4 Sep 1967, *Shimizu et al.* T8863 (SING); Plant cultivated at the Royal Botanic Garden Edinburgh; originally from Phu Krading [Kradueng] National Park, 1200 m, seeds from *Smitinand* 10471 collected 18 Oct 1968, flowered Edinburgh 15 Aug 1969, vouchered Sep 1977 as C6744, *accession no.* 19683012 (E); *ibid.*, C8459, *accession no.* 19741960 (E); *ibid.*, C8460, *accession no.* 19741960 (E); without locality, cultivated at Edinburgh 15 Sep 1961, C3717, *accession no.* 19611998 (E).

4. *Didymocarpus corchorifolius* Wall. ex DC.

Prodromus 9: 265 (1845) (*corchorifolia* R. Br.) [Wall., Numer. List 792 (1829), *nom. nud.*; R.Br. in Benn., Pl. Jav. Rar. 2: 119 (1840), *nom. nud.*]; Clarke, Monogr. Phan. 5 (1): 85 (1883) (*corchorifolia* R. Br.); Clarke, Fl. Brit. India 4: 351 (1884) (*corchorifolia* Wall.); Ridley, Fl. Malay Penins. 2: 508 (1923); Burt, Notes Roy. Bot. Gard. Edinburgh 21: 204 (1954); Barnett, Fl. Siam. 3(3): 212 (1962); Weber et al., Ann. Naturhist. Mus. Wien, B 102: 455 (2000); Burt, Thai For. Bull., Bot. 29: 91 (2001). TYPE: *Wallich* 792, Malaysia, Penang (lectotype G-DC, designated by Weber & Burt (1983), isotypes BM, E, G, GZU, K, K-W, L, M, WU). Fig. 1D.

Deciduous, epilithic, perennial herb, up to 60 cm tall. **Dry season** new shoots arising from the rhizome. **Dry season stems** erect, densely covered with multicellular eglandular hairs and sparsely covered with one-celled, conical, brown, pigment glands. **Dry season leaves** anisophyllous; blades subcoriaceous, ovate, 1–1.5 cm long, 0.8–1 cm wide, apex acute-acuminate, base obtuse, slightly oblique, margins crenate-serrate, upper surface densely covered hairs as on stem, lower surface densely covered with one-celled conical, brown, pigment glands, venation pinnate, secondary veins 5–6, ascending, obscure above, raised underneath, with dense multicellular eglandular hairs. **Rainy season stems** erect, zig-zag, all parts of plant always densely covered with one-celled, conical, brown, pigment glands. **Rainy season leaves** anisophyllous; blades subcoriaceous, upper surface dark green, lower surface pale green, oblong-lanceolate, 4–17 cm long, 2–6 cm wide, apex acute, base obliquely acute, margins serrate, covered with multicellular eglandular hairs on both sides, venation pinnate, secondary veins 11–14, ascending, obscure above, raised underneath; petioles 1–2.5



Fig. 1. **A.** *Didymocarpus aureoglandulosus* C.B.Clark. **B.** *D. bicolor* Craib. **C.** *D. biserratus* Barnett. **D.** *D. corchorifolius* Wall. ex DC. (Photos A, C, D: P. Nangngam, B: W. Makedd)

cm long, densely multicellular eglandular hairs. **Inflorescences** axillary, cymose, up to c. 9 cm long, few-flowered; peduncles 5–7 cm long, glabrous, light green; pedicels 3–5 mm long, glabrous, light green. **Bracts** paired, broadly ovate, 3 mm long, 5 mm wide, glabrous, light green. **Calyx** 5-lobed to the base, glabrous, lobes symmetrical, lanceolate, c. 3 mm long, 1 mm wide, apex acute, light green. **Corolla** personate, 2 cm long, glabrous, whitish; tube 1.5 cm long, widest at throat with a diameter to c. 1 cm; anterior (lower) lip 3-lobed, with a yellow alternipetalous streak below each sinus of the anterior lip, extending nearly to the base of the corolla, lobes sub-orbicular, 8 mm long, 6 mm wide, much longer than posterior lip, lateral lobes reflexed; posterior (upper) lip 2-lobed, lobes 7 mm long, 5 mm wide. **Fertile stamens** inserted at the base of the corolla tube; anthers orbicular, white, c. 2 mm long, c. 2 mm wide, white-bearded; filaments slender, 5 mm long, with moniliform hairs on the upper part; staminodes 3, reduced to filaments, 1–2 mm long. **Pollen** spheroidal, tricolpate with short apertures and verrucate sculpturing, 10 µm diameter. **Disc** tubular, c. 1.5–2 mm long, margins very irregular. **Ovary** 1 cm long, sparsely covered with glandular hairs; style 3–5 mm long, glabrous; stigma ligular, 2-lobed, the longer lobe thin, c. 1 mm long, the other lobe minute. **Capsules** erect, cylindric, green, pubescent, 3–4 cm long, c. 1 mm wide. **Seeds** elliptic, cell orientation straight, polygonate, faces smooth to slightly verrucate.

Distribution. Southern Thailand and western Peninsular Malaysia.

Ecology. Evergreen forest on exposed granite bedrock, along streams or on mossy cliffs and the shaded areas of quartzitic-epilite ridges.

Phenology. Flowering July–October, fruiting October–December.

Vernacular name. Kra Ding Dok Khao (กระดังงะดอกขาว).

Etymology. The specific epithet refers to having leaves like *Corchorus* (Tiliaceae).

Notes. *Didymocarpus corchorifolius* is distinct from the other species by the personate corolla with yellow streaks in the throat.

Specimens examined: THAILAND. **Songkhla.** Khao Nam Khang National Park, 2 Nov 2003, Palee 662 (CMU, E); *ibid.*, 21 Sep 2010, Middleton *et al.* 5501 (E); *ibid.*, 28 Aug 1995 Larsen, *et al.* 46087 (AAU). **Yala.** Betong District, Ban Ko, 8 Aug 2009, Wai 1123 (PSU).

5. *Didymocarpus dongrakensis* B.L.Burt

Thai For. Bull., Bot. 29: 91 (2001). TYPE: *Maxwell* 76-531, Thailand, Si Sa Ket, Kantaralak District, Dongrak Range, Chong Bat Lak, 14°30'N, 104°E, 17 Aug 1976 (holotype AAU; isotypes BK, E, L). Fig. 2A.

Deciduous, epilithic, perennial herb, 20–30 cm tall. *Stems* erect, glabrous, light green, all parts of plant densely covered with 4-celled, red-brown, pigment glands. **Dry season** new shoots arising from the rhizome. **Dry season leaves** anisophyllous, ternate; blades symmetrical, subcoriaceous, lanceolate, 1.5–2 cm long, 0.5–0.8 cm wide, apex acute, base acute, margins very shallowly serrulate, upper surface silver-grey, sericeous, lower surface sparsely sericeous on the veins, densely covered with brown pigment glands, venation pinnate, secondary veins 5–7, ascending, obscure above, prominent underneath. **Rainy season leaves** anisophyllous; blades subcoriaceous, oblong, lanceolate to elliptic, light green above, pale green beneath, 7.5–11.5 cm long, 2.5–4.5 cm wide, apex acute, base acute, slightly oblique, margins shallow serrulate, often entire in the lower half, upper surface sparsely covered with multicellular eglandular hairs, lower surface glabrous, venation pinnate, secondary veins 5–7; petioles terete, 1–6 cm long, glabrous. **Inflorescences** axillary, crowded among the upper leaves, cymose, 10–11 cm long; peduncles densely covered with multicellular glandular hairs, dull maroon to pinkish; pedicels 1–3 cm long. **Bracts** thin, lanceolate, 5 mm long, 2 mm wide, glabrous, light green-pale pinkish. **Calyx** symmetric, 5-lobed to the base, lobes linear-lanceolate, 2 mm long, 0.5 mm wide, apices acute, slightly reflexed, glabrous, dull light green. **Corolla** funnelform, c. 1.5 cm long, glabrous, tube light violet-pinkish; tube 1 cm long; anterior (lower) lip 3-lobed, lobes orbicular, c. 6 mm diameter, much longer than the posterior ones; posterior (upper) lip 2-lobed, lobes suborbicular, c. 4 mm long, 3 mm wide. **Fertile stamens** inserted above the middle of the tube; anthers oblong, c. 2 mm long, glabrous, cream; filaments 3–5 mm long, glabrous, white; staminodes 3, minute, posterior, unequal in length. **Pollen** spheroidal, 10 µm diameter, tricolpate, long apertures with granular elements, sculpturing microperforate. **Disc** tubular, margin irregularly lobed, c. 1.5 mm long. **Ovary** cylindrical, c. 1 cm long, glabrous, light green; style glabrous, whitish; stigma capitate, concave, reddish. **Capsules** erect, c. 1.3–1.5 cm long. **Seeds** elliptic, cell orientation straight.

Distribution. Northeast Thailand. Probably also in northern Cambodia.

Ecology. Shaded, moist, rugged sandstone gully in the upper catchment basin, in deciduous forest.

Phenology. Flowering July–August, fruiting August–October.

Vernacular name. Muang Dong Rak (ม่วงดงรัก).

Etymology. Specific epithet refers to the Dongrak Range.

Notes. *Didymocarpus dongrakensis* differs from *D. insulsus* Craib in the smaller and purple corolla. The stems and leaves of both taxa are otherwise quite similar.

Specimens examined: THAILAND. **Si Sa Ket.** Panom Dongrak Wildlife Sanctuary, Thai-Cambodia border, Chong Bat Lak area, Bak Dong Subdistrict, c. 610 m, 23 Oct 2003, *Palee 658* (A, BKF, C, CMU, E, L).

6. *Didymocarpus epithemoides* B.L.Burt

Thai For. Bull., Bot. 29: 92 (2001). TYPE: *Larsen et al.* 10683, Thailand, Nakhon Nayok, Khao Yai National Park, Khao Kieo [Khiao], c. 1350 m, 20 Jul 1963 (holotype E; isotypes AAU, C, E, BKF). Fig. 2B, Fig. 3.

Deciduous, perennial, epilithic herb, 30 cm tall. **Stems** single, erect, densely covered with whitish multicellular eglandular hairs. **Pigment** glands absent. **Dry season** new shoots arising from the rhizome. **Dry season leaves** opposite, anisophyllous; blades subcoriaceous, dark green above, pale green beneath, symmetric, elliptic, 1.5–2 cm long, 1–1.5 cm wide, apex obtuse, base acute, margins shallowly serrate, both sides densely covered with whitish, eglandular, multicellular hairs, venation pinnate, secondary veins obscure on both sides. **Petioles** 1–3 cm long, with indumentum as on the stem. **Rainy season** plants elongating from the rhizome. **Rainy season leaves** often solitary at base, much larger than the upper ones, upper leaves mostly paired and slightly anisophyllous; blades subcoriaceous, suborbicular to broadly ovate, 6–16 cm long, 4.5–15 cm wide, apex acute, base slightly oblique, rounded to shallowly cordate, margins finely serrate or finely doubly serrate, venation pinnate, secondary veins 5–6 pairs, ascending, obscure above, prominent below, upper surface densely covered with eglandular, multicellular hairs, sparsely so on the lower surface; petioles 5–9 cm long, covered with whitish multicellular eglandular hairs as on the stems. **Inflorescences** terminal or from the upper leaf axils, cymose, c. 10 cm long; peduncles 2–7.5 cm long, sparsely covered with multicellular glandular hairs, dull green-dull violet; pedicels 3–5 mm long, glabrous or sometimes with indumentum as on the peduncle, dull green-dull violet. **Bracts** orbicular, 5 mm long and wide, glabrous, violet-pale pinkish. **Calyx** symmetrically campanulate, c. 5 mm long, c. 4 mm diameter, glabrous, violet to maroon, margins shallowly 5-lobed, lobes much less than half the length of the calyx tube, c. 2.5 mm long, apices rounded. **Corolla** salverform, 3–3.5 cm long, glabrous or with few scattered multicellular glandular hairs outside, diameter c. 3 mm, dark violet; tube 2–2.5 cm long; corolla lobes suborbicular; anterior (lower) lip 3-lobed, c. 8 mm long, 6 mm wide; posterior (upper) lip 2-lobed, c. 4 mm long, 4 mm wide. **Fertile stamens** inserted c. 1.5–1.7 cm from the base of the corolla tube; anther locules c. 2 mm long, 1 mm wide, white-bearded; filaments slender, c. 6 mm long, glabrous; staminodes 3, glabrous, reduced to thin filaments of unequal lengths. **Pollen** spheroidal, tricolpate with long apertures, sculpturing microreticulate, 10–15 μm diameter. **Disc** cylindrical, irregularly lobed, c. 2 mm long. **Ovary** c. 15 mm long, glabrous; style c. 3 mm long, sparsely covered with gland-tipped unicellular hairs; stigma capitate, concave, c. 1.5 mm diameter, papillose, cream. **Capsules** erect, symmetrically cylindric, 2.5–3 cm long, glabrous. **Seeds** narrowly elliptic, cell orientation straight.

Distribution. East-central Thailand.

Ecology. In evergreen forest.

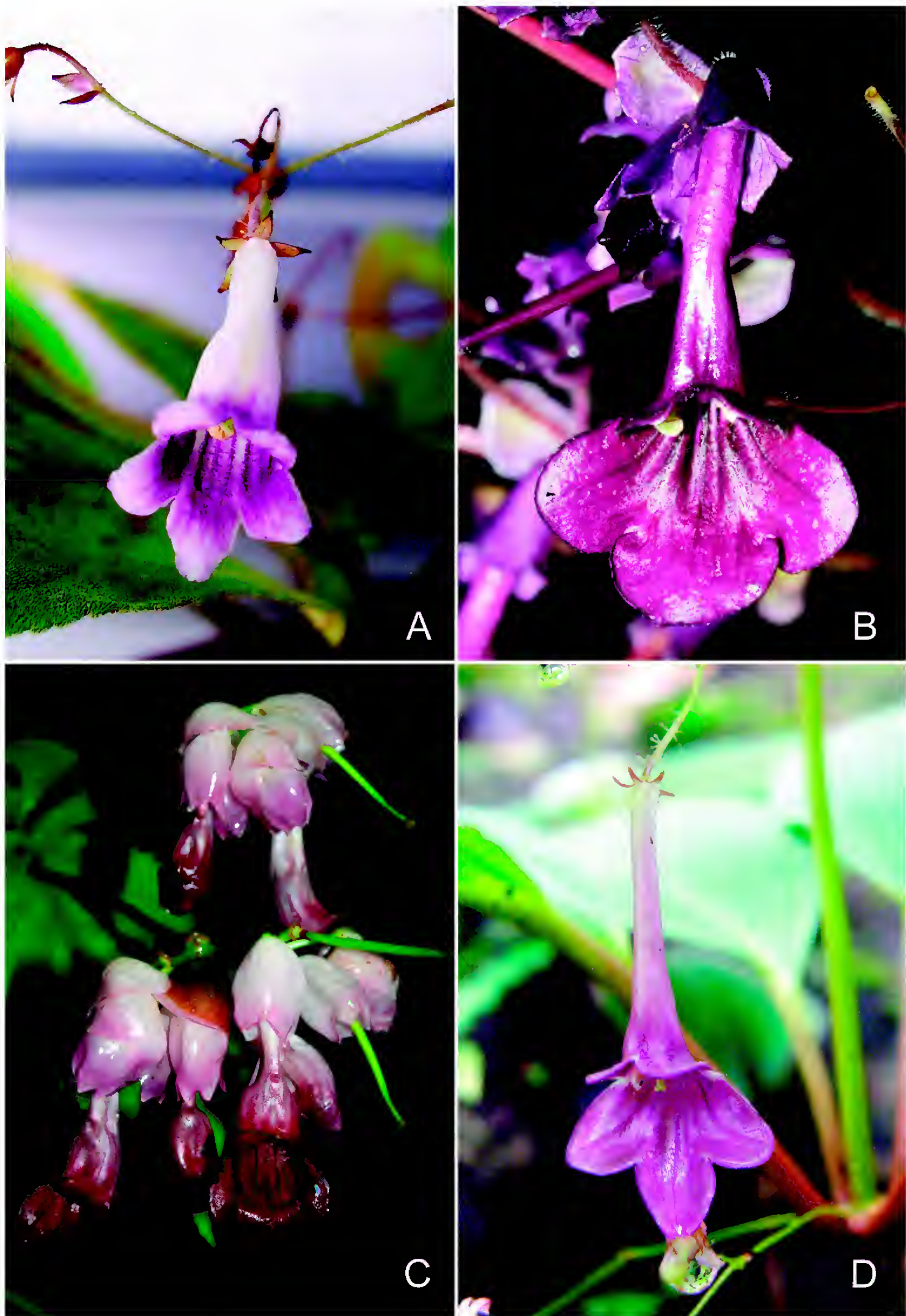


Fig. 2. **A.** *Didymocarpus dongrakensis* B.L.Burtt. **B.** *D. epithemoides* B.L.Burtt. **C.** *D. inflatus* J.F.Maxwell & Nangngam. **D.** *D. insulsus* Craib. (Photos A: P. Nangngam, B & C: P. Triboun, D: W. Makerd)

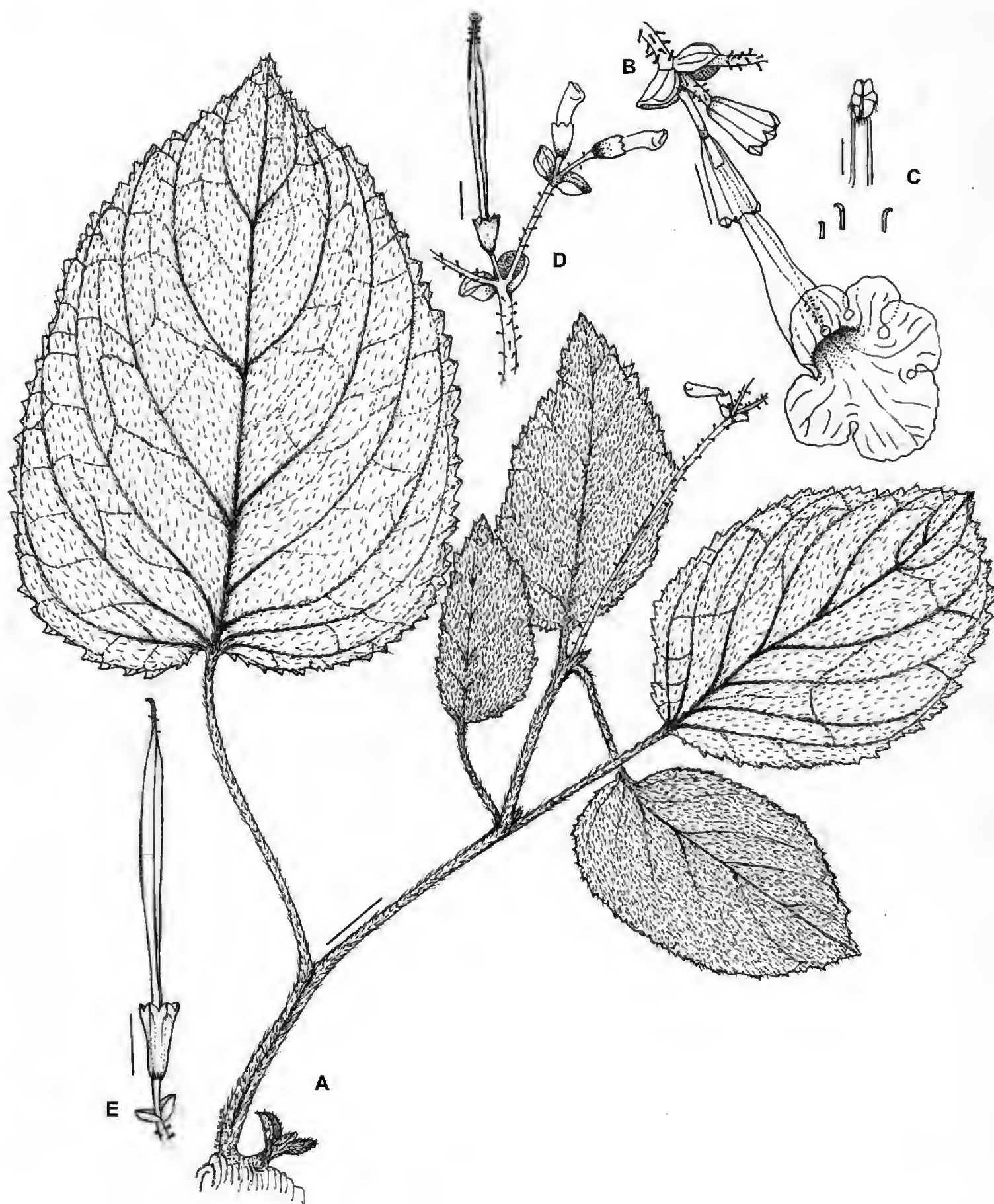


Fig. 3. *Didymocarpus epithemoides* B.L.Burt. **A.** Habit. **B.** Inflorescence. **C.** Stamens and staminodes. **D.** Ovary. **E.** Capsule. Scale bars: A=2 cm, B, D, E=5 mm, C=2 mm. (Drawn by P. Nangngam)

Phenology. Flowering June–July, fruiting August–October.

Vernacular name. Muang Khao Yai (ม่วงเขาใหญ่).

Etymology. The specific epithet refers to a similarity to species of the genus *Epithema* (Gesneriaceae).

Notes. *Didymocarpus epithemoides* differs from *D. biserratus* by the shorter corolla.

Specimens examined: THAILAND. **Nakhon Nayok.** Khao Yai National Park, Khao Kieo, evergreen forest, 19 Oct 1969, *Shimizu et al.* 19724 (BKF); *ibid.*, 1250 m, 20 Jul 1963, *van Beusekom & Charoenpol* 1757 (paratype E); *ibid.*, c. 1350 m, 7 Jul 1966, *Larsen et al.* 51 (BKF); northeast side of Kow Kiew [Khao Kieo], Pah Deo Dai, 150 m, 14 Aug 2000, *Maxwell* 00-404 (CMU); *ibid.*, 1200 m, 10 Jul 2003, *Palee* 603 (CMU); *ibid.*, c. 1100 m, 14 Aug 1993, *Kunwasi* 9 (BCU); *ibid.*, c. 750 m, 2 Dec 1983, *Fukuoka & Ito* T-34993 (BKF); *ibid.*, c. 1170 m, 23 Aug 2012, *Middleton et al.* 5653 (E); summit of Khao Kieo, c. 1250 m, 23 Aug 2012, *Middleton et al.* 5644 (E).

7. *Didymocarpus geesinkianus* B.L.Burt

Thai For. Bull., Bot. 29: 92 (2001). TYPE: *Geesink, Hattink & Charoenphol* 7416, Thailand, Ranong, Khao Pota Luang Kaeo, 8°50'N, 99°E, 700–900 m, 22 Jun 1974 (holotype L; isotypes AAU, BKF).

Deciduous, epilithic, perennial herb. **Dry season** plants unknown. **Rainy season stems** densely appressed-pubescent, c. 11 cm tall. All parts of plant distinctly covered with 4-celled, conical, red-brown, pigment glands. **Leaves** opposite, slightly anisophyllous, crowded at the top of the stem; blades subcoriaceous, oblong to lanceolate, c. 4.5–6.5 cm long, 2.5–4 cm wide, apex acute, base acute to cuneate, usually oblique, margins serrate, upper surface very densely white sericeous, sparsely so on the lower surface, densely on veins, venation pinnate, 5–6 pairs of ascending, secondary veins on each side of midrib, obscure above, raised underneath; petioles 2.5–3.5 cm long, with indumentum as on the stem. **Inflorescences** 1 or 2 from the upper leaf axils, cymose, c. 10 cm long; axes with sparse coarsely multicellular glandular hairs; peduncles 3–8 cm long; pedicels 0.8–1 cm long. **Bracts** paired, elliptic, c. 2–3 mm long, 0.5–2 mm wide, covered with multicellular glandular hairs, and sparsely covered with 4-celled, red-brown pigment glands outside, inside glabrous, soon caducous. **Calyx** irregular, pink; posterior (upper) lip composed of 2 free lobes, lobes lanceolate, c. 2.7–4 mm long, 1.2–1.7 mm wide; anterior (lower) lip of a tube at base and 3-lobed at apex with lobes half the length of the calyx tube, lobes c. 4–5 mm long, 2–8 mm wide, covered with multicellular glandular hairs outside. **Corolla** funnelform, c. 2.5 cm long, c. 2 mm diameter, glabrous, purple, ventral part of tube white, lobes purple; tube c. 1.8–2 cm long; lobes suborbicular; anterior (lower) lip 3-lobed, c. 5 mm long, 4 mm wide, much longer than the upper lip; posterior (upper) lip 2-lobed, slightly oblique. **Fertile stamens** inserted in upper part of the corolla tube; anthers c. 3 mm long, c. 2 mm wide, white-bearded; filaments slender, 5 mm long, glabrous; staminodes 3, posterior, reduced to thin filaments of unequal lengths, hairy at tips. **Ovary** glabrous, 12 mm long;

style glabrous, 2 mm long; stigma capitate, concave, papillose. **Capsules** glabrous, erect, symmetrically cylindrical, 2.2–2.7 cm long. Pollen and seed not seen.

Distribution. Southwest Thailand. Known only from the type locality.

Ecology. Only known from evergreen forest in an open place on clay-shale.

Phenology. Flowering June–July, fruting June–July.

Vernacular name. Tian Khao Pho Ta (เทียนเขาพ้อตา).

Etymology. The specific epithet honours Dr. Rob Geesink (1945–1992), a botanist from Leiden, the Netherlands.

Notes. *Didymocarpus geesinkianus* is a distinct species with readily observable unique characters but is only known from the type collection. It is perhaps a rare species.

8. *Didymocarpus inflatus* J.F.Maxwell & Nangngam, **sp. nov.**

A Didymocarpo biserrato folii basi oblique, bracteis calycibusque albis vel obscure dilute violaceis, calyce maiore (16–17 mm) corollis non purpureis, filamentis prope antheras pillis paucis multicellulosis apicaliter glandulosis, anthers glabris, discis obliquis irregulariter lobatis differt.

TYPE: *Maxwell 04-490*, Thailand, Chiang Mai, Mae Awn District, west side of Doi Lohn (Lahn) along Mae Gahm Bawng [Mae Kom Pong] Falls, c. 1125 m, 20 Sep 2004 (holotype CMU; isotypes A, BKF, CAS, L, MO). Fig. 2C.

Deciduous, perennial, epilithic herb, 32–60 cm tall. **Dry season** juvenile leaves distinct, blades with much denser indumentum than when mature. **Rainy season** stems succulent, with a few scattered, multicellular glandular hairs, glabrescent, light green. **Pigment** glands absent. **Leaves** opposite, decussate, anisophyllous; blades thin, upper surface dull dark green and drying medium brown, lower side pale light green and drying light brown, ovate, 6–19 cm long, 3.5–11 cm wide, apex acute, base obliquely rounded to cordate, margins serrate, often irregularly so, or doubly serrate, both sides with sparse and scattered, eglandular, multicellular hairs, midrib with 6–7 arching secondary veins on each side, distinct on both surfaces, finer venation reticulate; petioles 0.7–13.5 cm long, with indumentum as on the stems. **Inflorescence** terminal, erect, 14–19 cm long, glabrous, laxly cymose, axes succulent, light green; peduncles 5.5–7.5 cm long; pedicels c. 4 mm long. **Bracts** paired, concealing a pair of pedicels and embracing the lower part of the calyx, thin, elliptic, c. 8 mm long, 14 mm wide, concave, dull light violet to white and often white with a faint pinkish hue to purplish-white.

Flowers numerous. **Calyx** campanulate, glabrous, often white on both side; tube c. 1.5 cm long, throat 7–8 mm wide; lobes subequal, apices broadly rounded to acute; anterior 2 lobes 2–2.5 mm long, posterior 3 lobes 1.5–2 mm long. Bracts and calyx appearing inflated. **Corolla** funnelform, 4 cm long, glabrous, tube pale violet to reddish, upper part of the tube light violet to whitish, lower part violet to reddish, lobes very dark violet-reddish; tube gradually widening from the base to the throat, c. 3.5 cm long; lobes suborbicular, broadly rounded; anterior (lower) lip 3-lobed, 5–6 mm long, 7–8 mm wide, posterior (upper) lip smaller and 2-lobed. **Fertile stamens** inserted in the middle of the corolla tube, below the corolla throat; anthers oblong, c. 3 mm long, c. 1 mm wide, glabrous, cream; filaments flexed at the middle, very pale violet-white, c. 8 mm long, upper part covered with several minute, gland-tipped hairs; staminodes 3, inserted slightly below the stamens, lateral ones 4 mm long, the other one 2 mm long, glabrous. **Disc** tubular, thickened, glabrous, margin oblique and irregularly lobed, 2–3 mm high, persistent in fruit. **Ovary** cylindric, glabrous, light green, c. 2 cm long, 1 mm wide; style continuous with the top of the ovary, c. 5 mm long, glabrous, whitish or light green; stigma discoid, concave medially, whitish, 1 mm diameter. **Capsules** cylindric, erect, straight, light green and maturing light brown, 4.5–5 cm long, 2.5 mm wide. **Seeds** elliptic, cell ornamentation straight, cell faces finely verrucate.

Distribution. Northern Thailand.

Ecology. Moist, rugged places in primary evergreen or seasonal, hardwood forests on granite bedrocks.

Phenology. Flowering August–September, fruiting September–March, leaves May–October.

Vernacular name. Chomphu Phu Hin (ชมพู่หิน).

Etymology. The specific epithet refers to the seemingly inflated bracts and calyx.

Notes. *Didymocarpus inflatus* differs from *D. biserratus* particularly in the serrate leaf margin and the larger corolla.

Specimens examined: THAILAND. **Chiang Mai.** Mae Awn District, west side of Doi Lohn (Lahn) along Mae Gahm Bawng [Mae Kom Pong] waterfalls, c. 1125 m, 2 Mar 2005, *Carrot* 4 (CMU); Mae Lai Stream, c. 1150 m, 25 Oct 2005, *Palee* 839 (CMU); Mae On, trail to Mae Kom Pong waterfalls, c. 1100 m, 7 Sep 2011, *Pooma et al.* 7782 (E). **Phitsanulok.** Nakhon Thai District, Phu Hin Rong Kra National Park, trail to Lan Hin Pum, c. 600 m, 12 Oct 2003, *Palee* 642 (CMU); *ibid.*, 25 Sep 2005, *Palee* 802 (CMU); *ibid.*, 3 Sep 1988, *Giravatanapan* 1 (BCU); *ibid.*, 1200 m, 2 Sep 1995, *Herb trip* 1135 (BCU); *ibid.*, 10 Oct 2009, *Middleton et al.* 5070 (E).

9. *Didymocarpus insulsus* Craib

Bull. Misc. Inform. Kew 1926: 169 (1926) (*insulsa*); Pellegrin, Fl. Indo-Chine. 4(5): 522 (1930) (*insulsa*); Barnett, Fl. Siam. 3(3): 214 (1962); Weber et al., Ann. Naturhist. Mus. Wien, B 102: 458 (2000); Burt, Thai For. Bull., Bot. 29: 92 (2001). TYPE: *Unknown collector* 93, plant from Thailand cultivated in Aberdeen from seeds received from Dr. A.F.G. Kerr which flowered in Aberdeen in October 1925; collection locality of seeds not indicated, 3 Oct 1925 (holotype ABD). Fig. 2D.

Deciduous, perennial, epilithic herb; stems single, up to 30 cm tall, erect, glabrous, all parts with scattered, brown, 4-celled pigment glands. **Dry season** new shoots arising from the rhizome. **Dry season stems** glabrous. **Dry season leaves:** blades coriaceous, 2 cm long, 1 cm wide, venation pinnate, obscure above, prominent underneath. **Rainy season leaves** ternate or 3-pseudoverticillate, anisophyllous; blades subcoriaceous, dark green above, pale light green beneath, elliptic to oblong, 9.5–20 cm long, 6.5–13.5 cm wide, apex obtuse, base acute, margins shallowly, irregularly serrulate, upper surface sparsely sericeous with minute, multicellular eglandular hairs, lower surface glabrous, sparsely covered with pigment glands as on the stem, venation pinnate, secondary veins 6–9 pairs, ascending, obscure on the upper surface, prominent on the lower surface, brownish; petioles terete, 2–6 cm long, unequal in length, glabrous. **In-florescences** axillary, cymose, 5–15 cm long, axes sparsely covered with multicellular glandular hairs; peduncles pale green, 2.5–5 cm; pedicels maroon, 0.6–1.3 cm long. **Bracts** elliptic, 3–4 mm long, 3 mm wide, glabrous, green. **Calyx** 5-lobed to the base, lobes linear-lanceolate, 4 mm long, c. 1.5–2 mm wide, apices obtuse, glabrous, light green-reddish. **Corolla** funnelform, 2.5 cm long, pale violet or purple; tube c. 1.5 cm long; lobes suborbicular; anterior (lower) lip 3-lobed, c. 5 mm long, 6 mm wide, much longer than the posterior lobes; posterior (upper) lip 2-lobed, slightly ovate, c. 3 mm long, 6 mm wide. **Fertile stamens** inserted at c. 1.7 cm from the base of the corolla tube; anthers cream, oblong, c. 2 mm long, 1 mm wide, white-bearded; filaments glabrous; staminodes 3, reduced to filaments, 1–2 mm long. **Pollen** spheroidal, rugulate, 12–13 μ m. **Disc** slender, irregularly lobed, 2 mm high. **Ovary** glabrous, light green, 2 cm long; style glabrous; stigma capitate, concave, light green, 0.5 mm diameter. **Capsules** erect, symmetrically cylindric, glabrous, 3–4.5 cm long, 0.2 cm wide, calyx persistent. **Seeds** narrowly elliptic, c. 0.3 $\times$ 0.1 mm; testa cell orientation slightly spiral.

Distribution. North-Eastern Thailand.

Ecology. Moist places in primary evergreen forests on granite bedrock, near streams, on rocks.

Phenology. Flowering July–September, fruiting September–October.

Vernacular name. Kam Pong Din (กำปองดิน).

Etymology. The specific epithet means tasteless, without salt; the allusion of this epithet to this species is not understood.

Specimens examined: THAILAND. **Chiang Mai.** Doi Inthanon National Park, c. 600–700 m, dipterocarp forest, on rock by the stream, 19 Jul 1988, *Tamura T-6011* (BKF). **Chaiyaphum.** Pa-Hin Ngam Forest Park, c. 850 m, 4 Sep 1993, *Suddee 169* (BCU); Thep Sathit District, Wat Khao Pratuchumpon, c. 700 m, 20 Sep 1992, *O.T.1252* (BCU). **Nakhon Nayok.** Khao Yai National Park, Pah Da Baek Waterfalls, c. 750 m, 19 Oct 2003, *Palee 645* (CMU, E); *ibid.*, c. 660 m, 20 Aug 2012, *Middleton et al. 5634* (E); Pah Deo Dai, c. 1150 m, 14 Aug 2000, *Maxwell 00-391* (CMU); *ibid.*, c. 1170 m, 23 Aug 2012, *Middleton et al. 5651* (E); Khao Rom, c. 700–1200 m, 2 Dec 1983, *Fukuoka & Ito T-34610* (BKF). **Nakhon Ratchasima.** Sakaerat District, experimental Research Station, c. 360 m, 4 Dec 1983, *Fukuoka & M. Ito T-35034* (BKF); Khao Laem, c. 1100–1200 m, 19 Oct 1969, *van Beusekom & Charoenpol 1756* (E); Plant cultivated at Royal Botanic Edinburgh, originally from Khao Kieo, 1000–1200 m, seeds from *Smitinand 7558*, which flowered at Edinburgh in Sep 1964, vouchered as C4304 E00628027 (E), C4512 & E00628030 (E). **Loei.** Phu Kradung National Park, 4–5 km along the way to Wang Kwang Station, c. 1025–1200 m, 5 Oct 2003, *Palee 638* (CMU, E); along the trail to Headquarters National Park, c. 900–1200 m, *Gen Murata et al. T-42099* (BKF); Wat Phra Kaeo (RS-10) to Pha Nok En, sun set cliffs area, c. 1280–1260 m, 5 Sep 1988, *Takahashi & Tamura T-63384* (BKF); Plant cultivated at Royal Botanic Edinburgh, originally from Phu Krading [Kradueng] National Park, 1200 m, seeds from *Smitinand 10477*, collected 18 Oct 1968, which flowered at Edinburgh in Nov 1970, vouchered as C8069 & E00628026 (E).

10. *Didymocarpus jaesonensis* Nangngam & J.F.Maxwell, *sp.nov.*

A Didymocarpo kerrii calyce glabro, corollis strictis infundibularibus c. 3 cm longis, filamentis glabris, antheribus basi apiceque subtiliter puberulis, stigmatibus discoideo dif-fert.

TYPE: *Maxwell 96-1093*, Thailand, Lampang, Muang Bahn (Pan) District, Jae Sawn [Chae Son] National Park; 1225–1250 m, 21 Aug 1996 (holotype CMU; isotypes A, BKF, CAS, L, MO). Fig. 4A.

Deciduous, epilithic, perennial herb (4–)16–17 cm tall. **Dry season** plants unknown. **Rainy season** stems with scattered, multicellular eglandular hairs, pigment glands absent throughout plant. **Leaves** paired, anisophyllous; blades subcoriaceous, dark green above, pale light green beneath, oblong to lanceolate, 3.5–7 cm long, 1.5–4.5 cm wide, apex obtuse to bluntly acute, base symmetrically acute, margin shallowly and somewhat irregularly serrate, upper surface with scattered multicellular eglandular hairs, lower surface with indumentum as on upper surface, midrib with 4–5 ascending secondary veins on each side, obscure above, prominent underneath; petioles 2–4.5 mm long, with indumentum as on the stem. **Inflorescences** terminal, laxly cymose, (4–)9–13 cm long, axes with scattered multicellular glandular and eglandular hairs, rapidly glabrescent, dull dark violet, sometime glabrous; peduncle (2.2–)4–8 cm long; pedicels 4 mm long. **Flowers** numerous. **Bracts** paired at the base of a pair

of pedicels, broadly rounded, c. 8 mm long, 8 mm wide, glabrous, violet, caducous. **Calyx** of a campanulate tube and undulate margin, glabrous, violet; tube c. 7 mm long, 3–5 mm diameter. **Corolla** narrowly funnelform, straight, c. 3 cm long, glabrous, tube pale violet, throat with whitish streaks inside, lobes violet; tube c. 2 cm long, diameter c. 2 mm; lobes suborbicular; anterior (lower) lip 3-lobed, c. 5 mm long, 7 mm wide; posterior (upper) lip 2-lobed, slightly smaller. **Fertile stamens** inserted in the upper 1/3 of the corolla tube; anthers oblong, glabrous, cream, c. 2 mm long, 1 mm wide; filaments c. 6 mm long, glabrous in the lower part, multicellular glandular hairs in the upper part; staminodes 3, glabrous. **Disc** cylindric, coriaceous, margins obscurely undulate-truncate, c. 1 mm high, persistent in fruit. **Ovary** cylindric, slender, glabrous, dull brown-violet; style c. 4 mm long, continuous with the ovary, glabrous; stigma discoid, centrally depressed, c. 1 mm diameter. **Capsules** 3–4 cm long. **Seeds** elliptic, cell orientation straight, cell faces smooth, cell edges auriculate.

Distribution. Northern Thailand. Only known from the type locality.

Ecology. In evergreen forest, near streams or waterfalls.

Phenology. Flowering August, fruiting August–September, leaves in May–October.

Vernacular name. Khao Kam Pha Chae Son. (ข้าวกำผาแจ้ซอน).

Etymology. The specific epithet refers to Chae Son National Park, the type locality.

Notes. *Didymocarpus jaesonensis* resembles *Didymocarpus kerrii* Craib which differs in having multicellular glandular hairs on the calyx and a generally smaller salverform, geniculate corolla.

Specimens examined: THAILAND. **Lampang.** Muang Pan District, Chae Son National Park, trail to waterfall, c. 520 m, 12 Aug 2012, *Middleton et al.* 5568 (E).

11. *Didymocarpus kerrii* Craib

Bull. Misc. Inform. Kew 1911: 431 (1911); Pellegrin, Fl. Indo-Chine 4(5): 525 (1930); Barnett, Fl. Siam. 3(3): 215 (1962); Barnett, Dansk Bot. Ark. 20(2): 201 (1962); Weber et al., Ann. Naturhist. Mus. Wien, B 102: 458 (2000); Burtt, Thai For. Bull., Bot. 29: 91 (2001). TYPE: *Kerr* 786, Thailand, Chiang Mai, Doi Sutep [Suthep]-Pui National Park, on rocks in open jungle area, c. 1350 m, 5 Sep 1909 (holotype K; isotype E). Fig. 4B.

Didymocarpus squamosa Craib, Bull. Misc. Inform. Kew 1913: 71 (1913). TYPE: *Kerr* 2636, Thailand, Chiang Mai, Doi Sutep, on damp rocks in evergreen jungle, c. 900 m, 4 Aug 1912 (holotype K; isotype E).

Deciduous, perennial, epilithic herb. **Stems** single, erect, 4–21 cm tall, densely sericeous with multicellular eglandular hairs, all parts of plant sparsely covered with one-celled, golden-brown, peltate, pigment glands. **Dry season leaves:** blades coriaceous, symmetrical, ovate, 1.5 cm long, 1 cm wide, apex acute, base cordate, margins crenate, both sides densely covered with silvery or whitish multicellular eglandular hairs, venation pinnate, obscure on the upper surface, prominent on underneath; petioles c. 1 cm long, densely sericeous, with indumentum as on the stem. **Rainy season leaves** opposite, anisophyllous; blades subcoriaceous, dark green above, broadly elliptic to oblong-ovate, 4–10 cm long, 3–13 cm wide, apex obtuse, base shallowly and unequally cordate, margins coarsely crenate-serrate, venation pinnate, secondary veins 5–6 pairs, ascending, obscure on the upper surface, prominent and covered with indumentum as on the stem underneath, upper surface densely covered with whitish multicellular eglandular hairs, lower surface glabrous, otherwise main veins with scattered, adpressed, brownish multicellular eglandular hairs and pigment glands; petioles terete, 1–13 cm long, pairs slightly unequal, indumentum as on the stems. **Inflorescences** axillary, cymose, up to c. 7 cm long, many-flowered, axes dark green to dark violet; peduncles 2–5 cm long, sparsely covered with multicellular glandular hairs; pedicels dull green-dull violet, 3–5 mm long. **Bracts** suborbicular, 3.5 mm long, 4 mm wide, glabrous, violet-pale pinkish or whitish, caducous. **Calyx** symmetrically campanulate, 5 mm long, 3 mm wide, glabrous or sparsely covered with multicellular glandular hairs, pinkish-white or sometimes dark violet, 5-lobed, lobes less than half the length of the calyx tube, 2 mm long, 3 mm wide at base, apices rounded. **Corolla** salverform, 2–2.5 cm long, tube narrowly geniculate in the upper half, glabrous, tube violet with white lines ventrally, lobes dark violet, sometimes white, sometimes with 2 violet streaks below middle of anterior lip; tube 1.5 cm long; lobes rounded; anterior (lower) lip 3-lobed, lobes 4 mm long, 5 mm wide; posterior (upper) lip 2-lobed, lobes 3 mm long, 4 mm wide. **Fertile stamens** inserted 1.7 cm from the base of the tube; anthers oblong, c. 2 mm long, c. 1 mm wide, white, glabrous; filaments slender, geniculate, 4 mm long, glabrous; staminodes 3, reduced to unequal filaments, glabrous; 1–2 mm long. **Pollen** spheroidal, microreticulate-scabrate, 10–13 μm diameter. **Disc** cylindric, glabrous, irregularly lobed, 2 mm long. **Ovary** glabrous, 7–8 mm long; style glabrous, 2–3 mm long, 1 mm wide; stigma capitate, papillose, cream. **Capsules** erect, 2 cm long. **Seeds** elliptic, 0.27×0.12 mm, cell orientation straight, cell shape narrowly lineate-polygonate; cell edges slightly elevated and smooth, cell crests fused, faces slightly depressed and smooth.

Distribution. Northern Thailand.

Ecology. In evergreen forest, occurring on both limestone and granite bedrock.

Phenology. Flowering July–September, fruiting July–October.

Vernacular name. Kam Pong Din Dok Lek (กำปองดินดอกเล็ก).

Etymology. The specific epithet honours Dr. A.F.G. Kerr (1877–1942), a pioneer botanist in Thailand from 1902 to 1932.

Notes. The most distinctive character of this species is the strongly geniculate corolla tube.

Specimens examined: THAILAND. **Chiang Mai.** Doi Inthanon National Park, Doi Ang Ka, c. 1160 m, 9 Sep 1927, *Garret 441* (ABD); *ibid.*, c. 1300 m, 31 Aug 1958, *Larsen & Hansen 4649* (ABD); *ibid.*, c. 1400–1700 m, *Larsen & Larsen 34408* (AAU); north of km 38, c. 1700 m, 9 Sep 1994, *Maxwell 94-986* (CMU); Wachirathan waterfall, 8 Aug 1988, *H. Takahashi T-62781* (BKF); *ibid.*, 28 Jul 1988, *Phengkhlai et al. 7188* (BKF); Siriphum waterfall, 1360 m, 19 Sep 2008, *Middleton et al. 4506* (E); route to Mae Jaem, c. 1800 m, 26 Aug 1997, *BGO staff 9552* (QBG); Pha Ngaem (limestone cliffs), c. 1850 m, 26 Aug 2004, *Palee 702* (CMU); *ibid.*, c. 1925 m, 5 Oct 2004, *Palee 741* (CMU); Pa Ngem [Pha Ngaem], 6 Apr 1925, *Winit 1425* (K); Bong Noi village, along Huay Yaow stream, c. 1125 m, 15 Dec 2004, *Maxwell 04-804* (CMU); Doi Song Mea, Chom Thong, c. 1600 m, 21 Aug 1999, *Watthana et al. 586* (QBG). Doi Sutep-Pui National Park, Doi Mon Long, c. 1360 m, evergreen forest, 18 Sep 1995, *BGO staff 4544* (QBG), 3 Aug 1996, *BGO staff 6988* (QBG), 28 Sep 1997, *BGO staff 9678* (QBG); summit cliff of Doi Mon Long, c. 1400 m, 9 Aug 2002, *Palee 539* (CMU), 16 Sep 2002, *Palee 550* (CMU); *ibid.*, c. 1450–1475 m, 23 Aug 2002, *Maxwell 02-284* (CMU); Ban Huay Mae Sa Mai, 1275 m, 31 Oct 1989, *Maxwell 89-1338* (E); Huay Khok Ma, 1050–1275 m, 22 Nov 1989, *Maxwell 89-1433* (E); Doi Chang Kien, 1250 m, 28 Oct 1975, *Sadakorn 588* (E); *ibid.*, c. 1100 m, 16 Sep 2002, *Palee & Toktang 668* (CMU); *ibid.*, c. 1350 m, 13 May 1914, *Kerr 3443* (ABD); *ibid.*, c. 1350–1500 m, 9 Jan 1966, *Iwatsuki & Fukuoka 4484* (E); Doi Chiang Dao Wildlife Sanctuary, Huay Mae Gawk [Kok] (Den Yah Kat) Station, c. 1500 m, 22 Feb 2003, *Palee 568* (CMU); *ibid.*, 4 Nov 1995, *Maxwell 95-1066* (CMU); Mae Chaem, Doi Pha Ti Do, c. 1700 m, 21 Sep 2009, *Middleton et al. 4941* (E). **Lampang.** Jae Sawn [Jaeson] National Park, east side, along Mae Mawn stream at Jae Son waterfall, c. 525 m, 22 Aug 1995, *Maxwell 95-533* (CMU); *ibid.*, c. 500 m, 10 Aug 1996, *Panatkol 156* (CMU). **Nan.** Doi Phu Kha National Park, 1800 m, 31 Aug 2000, *Srisanga 1534* (E). **Phitsanulok.** Phu Soi Dao National Park, Tan Sa Wan Waterfalls, c. 1580 m, 14 Aug 2000, *Suksathan 2693* (QBG). **Uttaradit.** Klong Dtrawn [Tron] National Park, ridge above the upper water catchment valley of Klong (stream) Dtrawn, north side of Pu Miang, c. 1300 m, 14 Oct 2005, *Palee 808* (CMU).

12. *Didymocarpus megaphyllus* Barnett

Nat. Hist. Bull. Siam Soc. 20: 11 (1961); Barnett, Kew Bull. 15: 250 (1961); Barnett, Fl. Siam. 3(3): 215 (1962); Weber et al., Ann. Naturhist. Mus. Wien, B 102: 460 (2000); Burt, Thai For. Bull., Bot. 29: 92 (2001). TYPE: *Kerr 13215*, Thailand, Surat Thani, Ban Kawp, on rocks in evergreen forest, c. 100 m, 5 Aug 1927 (lectotype K, designated by Barnett in Kew. Bull. (1961); isotypes ABD, BK, BKF, BM). Fig. 4D.

Deciduous, perennial, epilithic herb up to 80 cm tall. *Stem* erect, green with sparsely scattered crimson blotches and multicellular eglandular hairs; pigment glands absent throughout plant. *Dry season* new shoots arising from the rhizome. *Dry season leaves*

opposite, decussate; blades subcoriaceous, dark green above, light green beneath, symmetrically ovate, 1.5–3 cm long, 1–1.5 cm wide, apex broadly acute, bases subcordate to truncate, margins crenate, sparsely adpressed puberulous on both sides, venation pinnate, obscure above, prominent underneath, covered with multicellular eglandular hairs along the veins; petioles terete, 3–8 cm long, pubescent as the blades. **Rainy season leaves** numerous, opposite, decussate, the pairs often anisophyllous; blades subcoriaceous, oblong to lanceolate, 12–19 cm long, 4–8 cm wide, apex acute, base oblique, one side somewhat rounded or acute, margins regularly crenulate-serrate, upper surface with scattered white multicellular eglandular hairs, dark green, lower surface glabrous, with scattered crimson blotches, light green, venation pinnate, secondary veins 7–11 pairs, sunken above, prominent underneath, covered with multicellular eglandular hairs; petioles terete, 2.5–10 cm long, pairs unequal, pale light green, with multicellular eglandular hairs or glabrous, and scattered crimson blotches as on the stem. **Inflorescences** axillary, arising from the leaf axils along stem, cymose up to c. 7 cm long; many-flowered; peduncles slender, 2–5 cm long, glabrous or with some multicellular glandular hairs, light green; pedicels 0.3–1.2 cm long, glabrous, light green. **Bracts** paired, hemispheric, 8 mm long, 5 mm wide, overlapping, glabrous, light green to dull green. **Calyx** symmetric, campanulate, c. 8 mm long, 3–4 mm diameter, tube slender, covered with multicellular glandular hairs; shallowly 5-lobed, lobes triangular, c. 2 mm deep, 1.5 mm wide, apices acute. **Corolla** funnelform, c. 3.5 cm long, covered with multicellular glandular hairs outside, crimson-red; tube c. 2 cm long, base narrow, c. 2 mm diameter, widening abruptly, especially on anterior side, widest at throat, diameter c. 1 cm diameter; anterior (lower) lip 3-lobed, lobes rounded, c. 6–8 mm long, 7–9 mm wide and more or less equal; posterior (upper) lip 2-lobed, lobes broadly rounded, 5 mm long, 7 mm wide. **Fertile stamens** inserted c. 2 cm above the base of the corolla; anthers oblong, c. 3 long, 1 mm wide, whitish, tips and bases rounded, white-bearded; filaments sparsely unicellular, gland-tipped hairs on the upper part, slender, 1 cm long; staminodes 3, glabrous, reduced to filaments, c. 3 mm long, tips ciliate. **Disc** cupular, c. 1.5 mm long, margins irregular. **Ovary** cylindrical, c. 3 cm long, glabrous, light green; style red-violet, covered with multicellular glandular hairs; stigma peltate, concave, papillose, whitish. **Capsules** erect, symmetrically cylindrical, 4.5–5 cm long. **Seeds** elliptic, apex truncate, 0.35×0.15 mm, cell orientation straight, cell shape lineate-polygonate, cell edges depressed and smooth, cell crests fused, cell faces elevated and tuberculate.

Distribution. Southern Thailand.

Ecology. In evergreen forest, along streams where the humidity is higher.

Phenology. Flowering August–October, fruiting September–December.

Vernacular name. Puang Sai Rung (พวงสายรุ้ง).

Etymology. The specific epithet is in reference to the large leaves (Greek).

Notes. The distinctive characters of this species are the dark red or crimson-red corolla, the overall pubescence, and the inflorescences in the axils of leaves along the stem.

Specimens examined: THAILAND. **Trang.** Sai Roong Waterfalls, Nah Chum Het Subdistrict, Yahn Dah Kow District, 175 m, 12 Dec 2003, *Palee* 686 (CMU); *ibid.*, 441 m, 5 Oct 2004, *Palee & Tantana* 752 (CMU, PSU). **Nakhon Si Thammarat.** Kiriwong, Tam Suae, 400 m, herb 80 cm tall, 19 Dec 1951, *Plermchit* 245 (E); Khao Luang National Park, 800 m, 21 Jul 1999, *Wattthana et al.* 484 (E).

13. *Didymocarpus newmanii* B.L.Burtt

Thai For. Bull., Bot. 29: 92 (2001). TYPE: *Newman* 926, Thailand, Chanthaburi, Khao Khitchakut, 12°34'N 102°16'E, 20 Jun 1999 (holotype E; isotype BKF). Fig. 4C, Fig. 5.

Deciduous perennial, epilithic herb. **Stems** single, erect, up to 20 cm tall, densely covered with multicellular eglandular hairs; pigment glands absent throughout plant. **Dry season** new shoots arising from the rhizome, bearing dry infructescence of the previous year. **Dry season leaves** ternate, anisophyllous; blades sericeous on both sides as on stem, venation pinnate, veins obscure both sides; petioles 5 mm long, with sparse indumentum as on the stem. **Rainy season leaves** anisophyllous; blades subcoriaceous, dark green above, pale green beneath, asymmetrically elliptic, 6–11.5 cm long, 3–5.5 cm wide, apex acute, base rounded to acute, margins irregularly coarsely doubly dentate, upper surface densely covered with white, multicellular eglandular hairs, concealing the tertiary veins, lower surface sparsely covered with eglandular as on upper surface, densely so on the veins; venation pinnate, with 5–8 pairs of ascending secondary veins on each side, obscure on the upper surface, prominent on lower surface; petioles terete, 1.5–4 cm long, unequal in length, with indumentum as on the stem. **Inflorescences** axillary, terminal, often paired, laxly, cymose, to c. 12 cm long, glabrous; peduncles slender, 2–2.5 cm long, glabrous, light green; pedicels 1–2 cm. **Bracts** ovate-orbicular, c. 2 mm long, 2 mm wide, apex acute, glabrous. **Calyx** 5-lobed to the base, lobes lanceolate, 2 mm long, 1 mm wide, apex obtuse, glabrous, light green. **Corolla** obliquely campanulate, c. 1–1.2 cm long, glabrous, white; tube very short, 3 mm long; anterior (lower) lip 3-lobed, mid-lobe c. 3 mm long, 4 mm wide; posterior (upper) lip 2-lobed, lobes rounded, c. 2 mm long, 3 mm wide. **Fertile stamens** inserted at the base of the corolla tube; anthers cream, bearded, c. 1 mm long; filaments c. 2.5 mm long, upper part sparsely covered with gland-tipped, unicellular hairs; staminodes 3, posterior, reduced to minute filaments. **Disc** annular, margins undulate, c. 0.25 mm high. **Ovary** cylindrical, 4 mm long, glabrous, light green; style whitish, 4 mm long, covered with gland-tipped, hairs. **Capsules** erect, glabrous, green, 7 mm long. **Seeds** numerous, narrowly elliptic, 0.4 × 0.12 mm, cell orientation straight, cell shape narrowly lineate-polygonate.

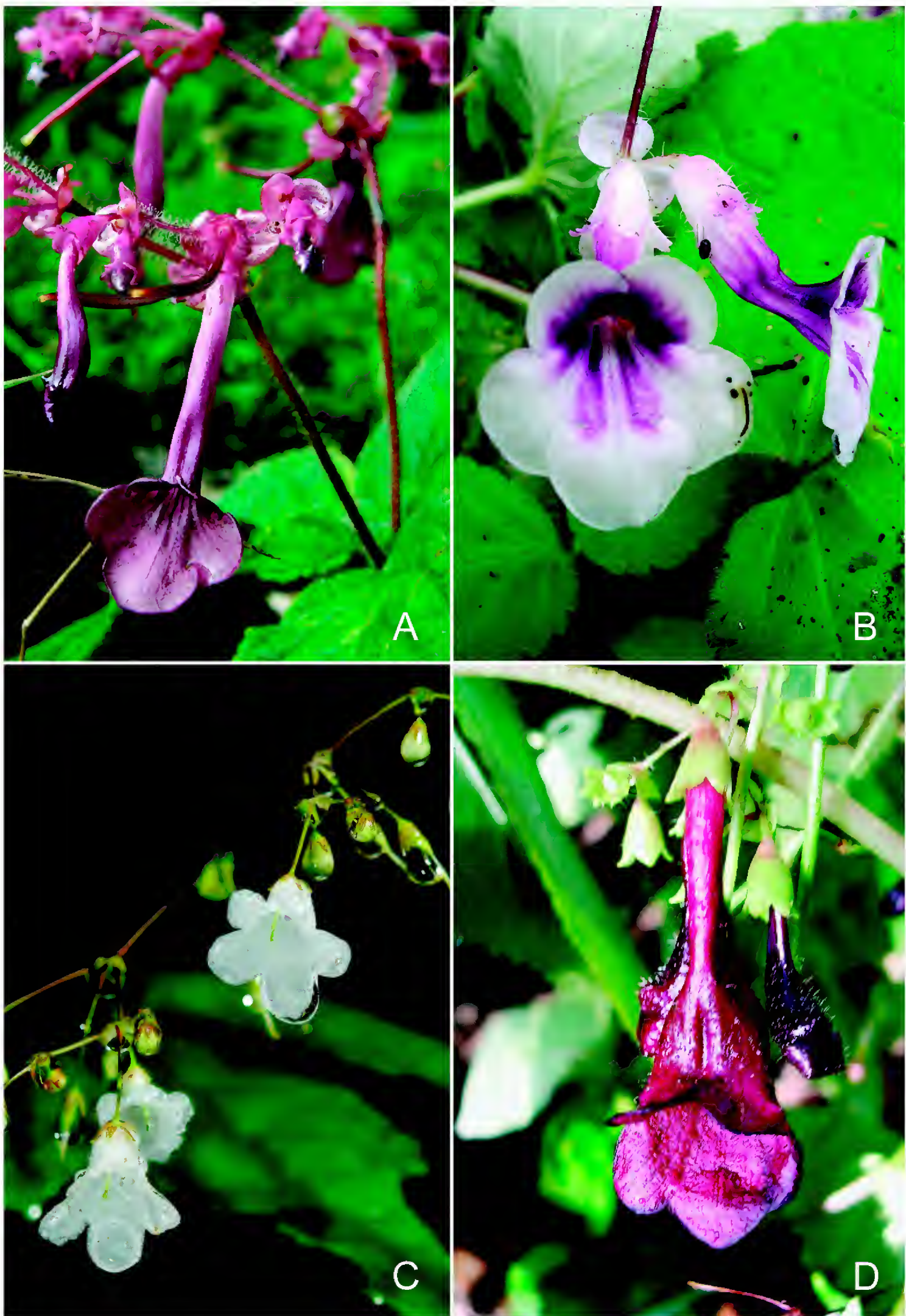


Fig. 4. A. *Didymocarpus jaesonensis* Nangngam & J.F.Maxwell. B. *Didymocarpus kerrii* Craib. C. *D. newmanii* B.L.Burt. D. *D. megaphyllus* Barnett. (Photos A: W. Makerd, B & C: P. Nangngam, D: P. Karaket)

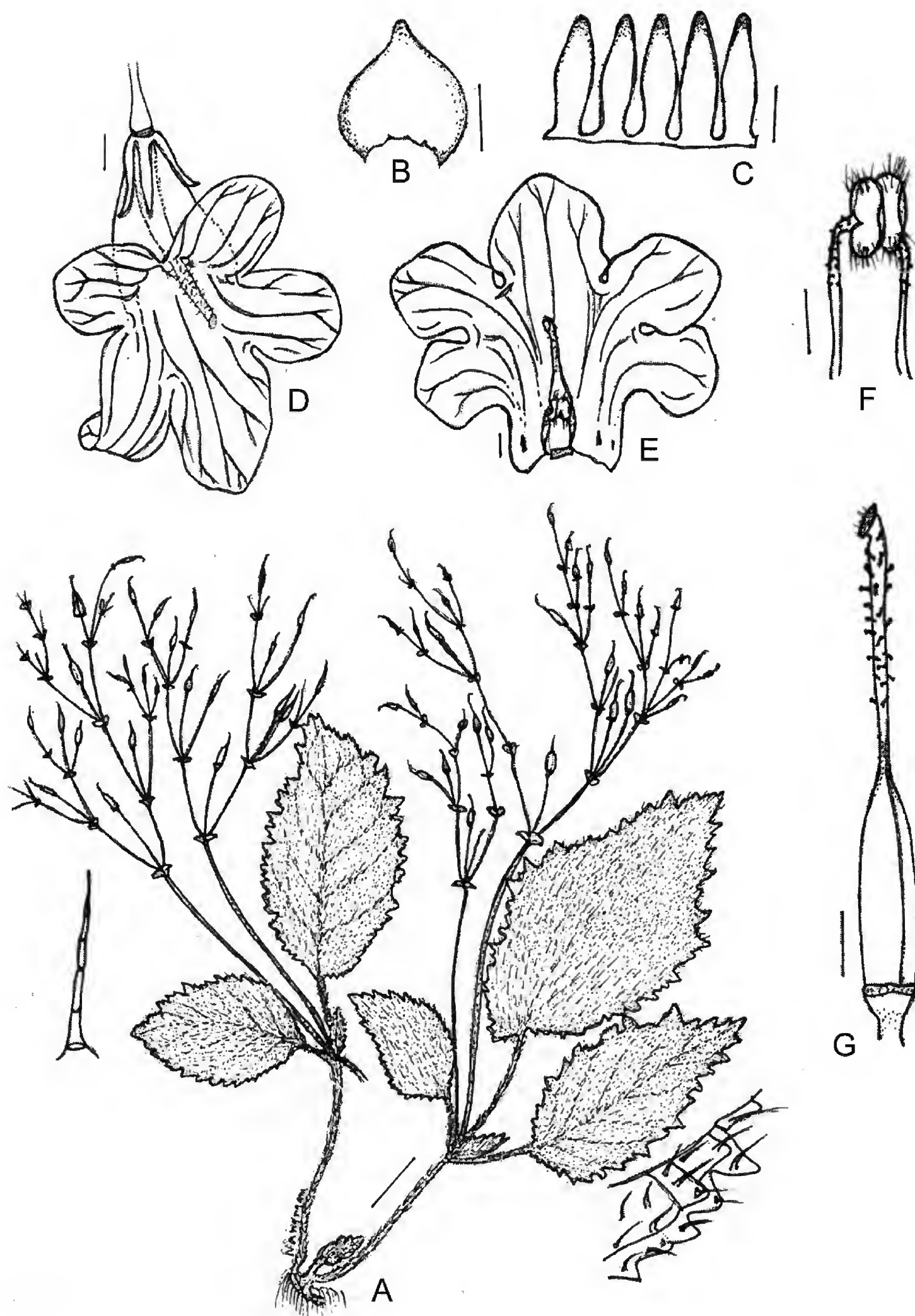


Fig. 5. *Didymocarpus newmanii* B.L.Burt. **A.** Habit. **B.** Bract. **C.** Calyx. **D.** Corolla. **E.** Opened corolla. **F.** Stamens. **G.** Capsule. Scale bars=1 mm. (Drawn by P. Nangngam)

Distribution. Only known from Chanthaburi Province.

Ecology. In evergreen forest, on moist cliffs, granite bedrock.

Phenology. Flowering June–July, fruiting August–December.

Vernacular name. Khao Tok Rue Si (ข้าวตอกฤๅษี).

Etymology. The specific epithet honours the collector of the type specimen, Dr. Mark Newman (born 1959), botanist in Edinburgh, Scotland, UK.

Notes. The spelling of the specific epithet has been changed from the spelling “newmannii” in the protologue to the correct spelling “newmanii”. The original “newmanii” is a typographical error to be corrected under Art. 60.1 of the ICN (McNeill et al. 2012).

Specimens examined: THAILAND. **Chanthaburi.** Khao Kitchakut National Park, Khao Pra Bat, c. 640 m, 13°27'N 101°58'E, 13 Aug 2000, *Phonsena* 2675 (BKF); *ibid.*, c. 850 m, along the way to the summit of Khao Kitchakut, 8 Jul 2002, *Palee* 532 (CMU); *ibid.*, c. 1200 m, 24 Sep 2003, *Palee* 622 (CMU); *ibid.*, 800 m, 27 Aug 2012, *Middleton et al.* 5672 (E).

14. *Didymocarpus ovatus* Barnett

Nat. Hist. Bull. Siam Soc. 20: 12 (1961); Barnett, Kew Bull. 15: 251 (1961); Barnett, Fl. Siam. 3(3): 216 (1962); Weber et al., Ann. Naturhist. Mus. Wien, B 102: 461 (2000); Burtt, Thai For. Bull., Bot. 29: 93 (2001). TYPE: *Kerr* 13259, Thailand, Surat, Kao Nawng, on rocks in evergreen forest, c. 900–1200 m, 10 Aug 1927 (lectotype K, designated by Barnett in Kew Bull. (1961); isotypes ABD, BK). Fig. 6A.

Deciduous, epilithic, perennial herb up to 30 cm tall. **Stems** erect, densely sericeous with multicellular eglandular hairs; pigment glands absent throughout plant. **Dry season leaves** opposite, anisophyllous; blades subcoriaceous, ovate, 2 cm long, 1 cm wide, apex acute, base obtuse, margins serrate, densely sericeous on both sides, venation obscure. **Rainy season leaves** opposite, anisophyllous; blades subcoriaceous, dark green above, pale green beneath, ovate, 5–14.5 cm long, 3–5.5 cm wide, apex acute, bases attenuate, upper surface very densely covered with multicellular eglandular hairs, concealing the tertiary veins, lower surface pubescent as on upper surface, more so along the veins; petioles 1.5–9 cm long, unequal in length, with indumentum as on the stem. **Inflorescences** axillary, from the upper node, cymose, up to c. 12 cm long; peduncles 6–9 cm long, sparsely covered with multicellular glandular hairs, green-maroon; pedicels c. 3–5 mm long, densely covered with indumentums as on the peduncles, light green. Lower **bracts** orbicular, c. 4 mm long, 4 mm wide, apex rounded, sometimes carinate, pinkish, glabrous, veins conspicuous; upper bracts smaller than the lower

ones, obovate-oblong, c. 3–4 mm long, 1–1.5 mm wide, pinkish turning whitish. **Calyx** 5-lobed to the base, lobes lanceolate, glabrous, c. 4 mm long, 1.5–2 mm wide, apex acute, violet or greenish-whitish. **Corolla** c. 2.5 cm long, salverform, glabrous, tube dark violet or reddish, becoming paler to white, lobes reddish; tube c. 2 cm long, basal diameter c. 2 mm; anterior (lower) lip 3-lobed, lobes elliptic, c. 4 mm long, 6 mm wide; posterior (upper) lip shallowly, 2-lobed, emarginate. **Fertile stamens** inserted near the middle of the corolla tube; anthers elliptic, c. 2 mm long, 1 mm wide, apex and base rounded, white, densely white-bearded; filaments slender, c. 4.5 mm long, glabrous; staminodes 3, unequal, reduced to filaments, 1–2 mm long, glabrous. **Pollen** spherical, aperture long, sculpturing micro-reticulate, 10–11 μ m. **Disc** cylindric, margins irregularly lobed, 1–1.5 mm long. **Ovary** glabrous, c. 1 cm long; style slender, c. 1.8 cm long, glabrous; stigma globose, peltate, concave, c. 1 mm diameter. **Capsules** erect, c. 2–2.5 cm long, glabrous. **Seeds** numerous, narrowly elliptic, c. 0.28 $\times$ 0.10 mm, apex truncate, cell orientation straight.

Distribution. Southern Thailand.

Ecology. In evergreen forest, along stream and waterfalls, granite bedrock.

Phenology. Flowering June–August, fruiting October–November.

Vernacular name. Tian Hin (เทียนหิน).

Etymology. The specific epithet refers to the shape of the leaves.

Notes. *Didymocarpus ovatus* is similar to a number of northern Thai species where the calyx lobes are free to the base but is distinctive in its dark violet to reddish corolla.

Specimens examined: THAILAND. **Songkhla.** Dton [Ton] Nga Chang Falls, c. 500 m, near the stream, 21 Aug 1992, *Niyomdham* 3130 (AAU, BKF); *ibid.*, c. 475 m, 4 Nov 2003, *Palee* 664 (CMU). **Nakhon Si Thammarat.** Khao Luang, c. 1600 m, 25 Jun 1953, *Phloenchit* 584 (E); *ibid.*, c. 600 m, 31 Aug 1952, *Phloenchit* 418 (E); *ibid.*, c. 1100–1786 m, on mossy rocks in deep shade, 21 Jan 1966, *Tagawa et al.* 4852 (E); Nam Tok Yong National Park, c. 50 m, 4 Oct 1972, *Smitinand* 11698 (E); *ibid.*, 3 Dec 1972, *Santisuk et al.* 262 (E); *ibid.*, c. 140–150 m, 9 Oct 2002, *Palee* 553 (CMU); *ibid.*, c. 130 m, 9 Feb 2005, *Williams et al.* 1337 (E). **Krabi.** Khao Panom Bencha National Park, c. 1200 m, trail to summit of Khao Panom Bencha, 19 Jun 2006, *Williams et al.* 1940 (E). Without locality, cultivated in Aberdeen in 1930, E00628037, *Kerr* 206, (E, K, US) & in 1929, *Kerr* 197 (K), *Kerr* 198 (K).

15. *Didymocarpus payapensis* Nangngam & J.F. Maxwell, **sp. nov.**

A Didymocarpus insulsus caulibus brevioribus (ad 10 cm longis, nec ad 30 cm longis), calyce c. 2.5 mm longo ad c. 2/3-plo lobato, lobis patentibus ad reflexis (nec liberis erectisque) c. 1.5 mm longis differt.

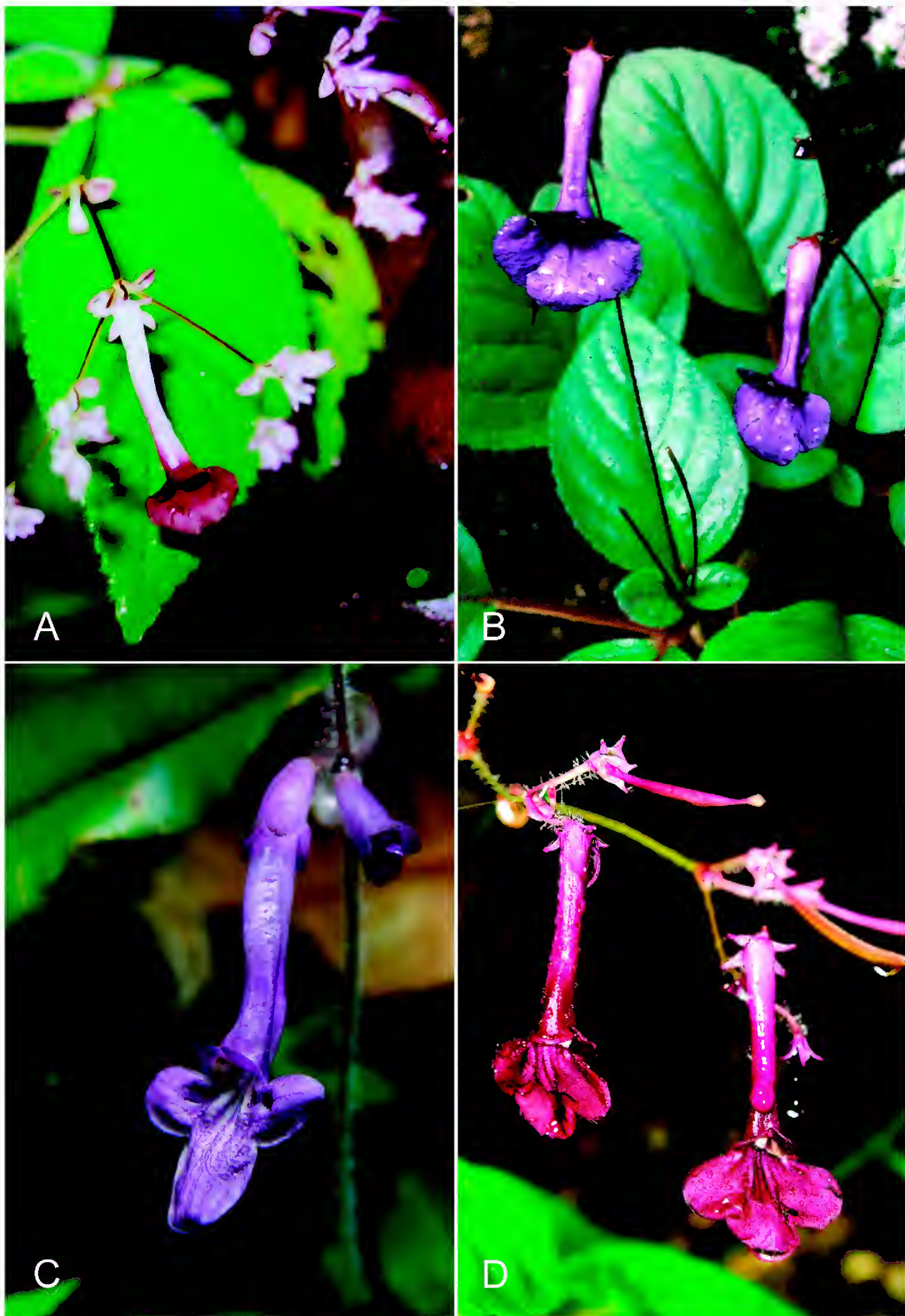


Fig. 6. **A.** *Didymocarpus ovatus* Barnett. **B.** *D. payapensis* Nangngam & J.F.Maxwell. **C.** *D. purpureopictus* Craib. **D.** *D. tristis* Craib. (Photos A: P. Nangngam, B: S. Gardner, C: W. Makerd, D: P. Karaket)

TYPE: *Maxwell 93-1098*, Thailand, Lamphun, Doi Kuhn Dtan [Tan] National Park, 825 m, 24 Sep 1993 (holotype CMU; isotype L). Fig. 6B, Fig. 7.

Deciduous, perennial, terrestrial or epilithic herb. **Rhizome** 1–2 cm long, 0.5–1.5 cm, thick. **Stems** erect, unbranched, up to c. 10 cm tall; sparsely to densely covered with whitish, multicellular eglandular hairs, dull green to medium green, all parts of plant covered with dark brown, 4-celled, pigment glands. **Dry season leaves** clustered on the rhizome; blades 5–10 mm long and wide, densely sericeous with multicellular eglandular hairs above, lower surface mostly glabrous and with scattered pigment glands, venation pinnate, obscure on both sides. **Rainy season leaves** ternate or opposite and decussate, pairs slightly anisophyllous; blades subcoriaceous, medium to dark green above, pale dull light green beneath, elliptic, 6–12 cm long, 2–9 cm wide, apex obtuse, base acute to rounded, margins shallowly and irregularly serrulate, lower part more entire, upper surface sparsely sericeous with minute, multicellular eglandular hairs, lower surface glabrous, except for the main veins, with scattered, 4-celled, dark brown pigment glands, venation pinnate, secondary veins ascending, 5–7 on each side of the midrib, sunken above, prominent underneath; petioles sulcate above, 2–8 cm long, with indumentum as on the stem. **Inflorescences** axillary, laxly and broadly cymose, many-flowered, with occasional multicellular glandular hairs and scattered pigment glands, green to maroon, c. 10 cm long; peduncles 3–7 cm long; pedicels 0.5–1.5 cm long. **Bracts** lanceolate, 2–3 mm long, c. 0.8 mm wide, green, sparsely covered with indumentum as on the inflorescence axes, rapidly caducous. **Calyx** symmetrically campanulate, sparsely covered with multicellular glandular hairs and scattered pigment glands, maroon; calyx tube 2.5 mm long, lobed c. 2/3 to the base; lobes spreading to reflexed, equal, triangular, c. 1.5 mm long, apices obtuse. **Corolla** c. 2.5 cm long, salverform, glabrous, dark purple; corolla tube c. 2 cm long, basal diameter c. 3 mm; anterior (lower) lip 3-lobed, lobes rounded, c. 5 mm high, 6 mm wide; posterior (upper) lip 2-lobed, lobes rounded, c. 3 mm high, 4 mm wide. **Fertile stamens** inserted above the middle of the corolla tube; anthers oblong, c. 2 mm long, cream, tips and bases rounded, white-bearded; filaments slender, c. 5 mm long, glabrous, white; staminodes 3, posterior, reduced to minute filaments, glabrous, whitish-very pale light greenish. **Pollen** 10–11 μm , spheroidal, tricolpate with long aperture, sculpturing micro-reticulate. **Disc** cylindric, margin irregularly lobed, glabrous, c. 1.5 mm high. **Ovary** cylindric, glabrous, light green, c. 7 mm long; style c. 3.5 mm long, sparsely covered with multicellular glandular hairs; stigma discoid, peltate, reddish, c. 1.2 mm diameter. **Capsules** erect, symmetrically cylindric, c. 2 cm long, glabrous. **Seeds** elliptic, 0.31×0.14 mm, cell ornamentation straight, cell shape lineate-polygonate, cell edges elevated and smooth, cell crests fused, faces depressed and smooth.

Distribution. Northern Thailand.

Ecology. Open, moist areas in evergreen forest, near streams, on granite bedrock.

Phenology. Flowering September, fruiting September–November.

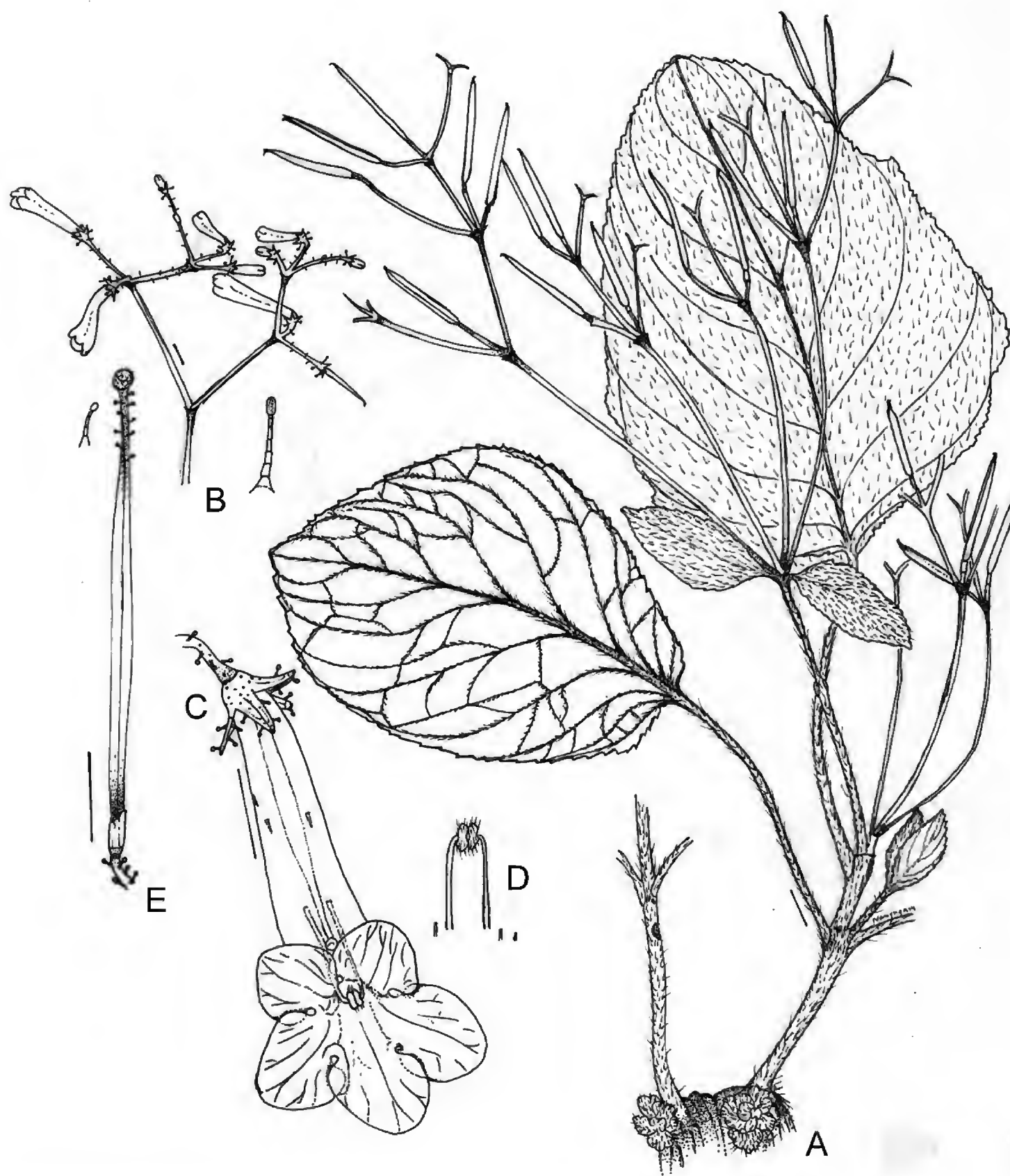


Fig.7. *Didymocarpus payapensis* Nangngam & J.F.Maxwell. **A.** Habit (holotype: Maxwell 93-1098, CMU). **B.** Inflorescence. **C.** Calyx and corolla. **D.** Stamens and staminodes. **E.** Capsule. Scale bars: A=1 cm; B, C, E=5 mm. (Drawn by P. Nangngam)

Vernacular name. Muang Pha Yap (ม่วงพ้ายัพ).

Etymology. The specific epithet refers to the region of north-west Thailand.

Notes. Barnett (1962a: 215), under *Didymocarpus insulsus* Craib, indicated that three

specimens (*Kerr* 6277, *Winit* 749 and *Winit* 1164), all from northern Thailand, differed from *D. insulsus* in having the calyx lobed c. 1/2–2/3 to the base of the calyx tube. These specimens, along with a number of additional collections, belong to what we describe here as *D. payapensis*. *Didymocarpus insulsus* was described from material cultivated in Aberdeen, Scotland which was grown from seeds collected by Dr. Kerr from a now unknown locality in Thailand. Barnett was reluctant to describe a new species based on these three specimens since environmental conditions were thought to be possible reasons for their differences from the type of *D. insulsus*. Plant stature could possibly be influenced by habitat, but not a morphological feature such as the degree of calyx lobing. We have seen several specimens with this morphology and a molecular phylogenetic study showed a well supported separation between *D. payapensis* and *D. insulsus* (Palee et al. 2006). *Didymocarpus insulsus* Craib, as far as we can determine, is found only in the Chaityaphum, Loei and Nakhon Nayok (Khao Yai National Park) Provinces.

Specimens examined: THAILAND. **Chiang Mai.** Mae Chem, 1500 m, 14 Sep 1922, *Kerr* 6277 (K); Aob Kahn National Park, Kuhnwin village, 4 Oct 2001, *Sangkamathawee & Palee* 499 (CMU); Mae Awn District, above Mae Lai village, c. 1150 m, 25 Oct 2005, *Palee* 836 (CMU); Doi Sutep-Pui National Park, west side of Pah Glawng, above Mae Sa Mai village, c. 1300 m, 5 Dec 2007, *Maxwell* 07-718 (CMU). **Chiang Rai.** Doi Tung, Mae Sai District, in front of the entrance to Wat Pra Tat Doi Dtung [Tung], c. 1375–1400 m, 5 Nov 2004, *Palee* 761 (CMU); *ibid.*, 30 Oct 2005, *Palee* 871 (CMU). **Lampang.** Mae Ngow, c. 440 m, 26 Aug 1922, *Winit* 749 (K); *ibid.*, c. 300 m, 4 Sep 1923, *Winit* 1164 (K). **Lamphun.** Doi Kuhn Tan National Park, along the trail to Mah Meun station, c. 825 m, 29 Sep 2001, *Palee* 495 (CMU); *ibid.*, 10 Oct 2003, *Palee* 641 (CMU). **Uttaradit.** Klong Tron National Park, Nam Pad District, west slope of Pu Miang, along the way to Huay Sai waterfalls, c. 1550 m, 16 Oct 2005, *Palee* 815 (CMU).

16. *Didymocarpus purpureopictus* Craib

Bull Misc. Inform. Kew 1911: 431 (1911); Pellegrin, Fl. Indo-Chine 4(5): 523 (1930) (*purpureo-pictus*); Barnett, Fl. Siam. 3(3): 217 (1962) (*purpureo-pictus*); Weber et al., Ann. Naturhist. Mus. Wien, B 102: 464 (2000); Burt, Thai For. Bull., Bot. 29: 93 (2001). TYPE: *Kerr* 1414, Thailand, Chiang Mai: Doi Sutep [Suthep], on rocks by a stream, 750 m, 25 Sep 1910 (holotype K; isotypes BM, E). Fig. 6C.

Deciduous, perennial, epilithic herb. **Stems** erect, 15–30 m high, densely covered with whitish multicellular glandular hairs, all plant parts sparsely covered with one-cell, globose, red-brown, pigment glands. **Dry season leaves** opposite, decussate; blades subcoriaceous, ovate, c. 2 cm long, 1.5 cm wide, apex acute, base subcordate, margins serrulate, upper surface covered with whitish multicellular eglandular sericeous hairs, concealing the veins, lower surface sparsely covered with indumentum as on the upper surface and with scattered pigment glands; petioles terete. **Rainy season** stems simple, erect, densely covered with multicellular eglandular hairs, caducous. **Rainy season**

leaves: blades subcoriaceous, dark green above, pale light green beneath, elliptic to oblong, 12–20.5 cm long, 7–9 cm wide, apex bluntly acute, basal oblique, subcordate, margins serrulate, upper surface densely covered with multicellular eglandular hairs, lower surface glabrous, with scattered pigment glands, venation pinnate with 4–8 pairs of ascending secondary veins, curved near the margin, concealed by indumentum, prominent underneath; petioles 4–8 cm long, with indumentum as on the stem. **Inflorescences** cymose, terminal, and axillary from the upper nodes, up to c. 8 cm long, axes covered with multicellular glandular hairs, sometimes glabrescent, light green; peduncles 5–6 cm long; pedicels 3–5 mm long. **Bracts** ovate-orbicular, c. 3–4 mm long, c. 5 mm wide, glabrous, pale green-dull green, caducous. **Calyx** symmetrically campanulate, glabrous, whitish; tube c. 3–4 mm long, 2–3 mm diameter; shallowly 5-lobed, lobes triangular, 2.5 mm deep, 3 mm wide, apices acute. **Corolla** salverform, 2.5 cm long, glabrous, purplish; tube c. 1.5 mm long, narrow not enlarged, c. 3–4 mm diameter; anterior (lower) lip 3-lobed, c. 4 mm long, 4 mm wide, posterior (upper) lip 2-lobed, c. 3 mm long, 3 mm wide. **Fertile stamens** inserted at c. 1 cm from the base of the tube; anthers whitish, elliptic, white-bearded; filaments slender, 5 mm long, with sparsely unicellular, gland-tipped hairs in the upper part; staminodes 2, slender, reduced to filaments. **Disc** cylindric, margin irregularly lobed, glabrous, c. 1.5 mm long. **Ovary** cylindric, glabrous, pale pinkish, stalk c. 5 mm long, ovary c. 1 cm long, 3 mm wide; style c. 5 mm long, covered with gland-tipped hairs; stigma capitate, reddish. **Capsules** erect, cylindric, slightly curve, up to 3 cm long. **Seeds** not studied.

Distribution. North-Eastern Thailand.

Eccology. Moist areas in evergreen forest and sometimes in degraded areas on granite bedrock.

Phenology. Flowering July–August, fruiting August–September.

Vernacular name. Pra Dap Pha (ประดับผา).

Etymology. The specific epithet refers to the purplish colour of the corolla.

Notes. *Didymocarpus purpureopictus* is most easily recognised by the tubular calyx and the pale violet to whitish corolla.

Specimens examined: THAILAND. **Mae Hong Son.** Bahng Mah Pah District, 400 m, 5 Aug 1999, *Maxwell 99-82* (CMU). **Chiang Mai.** Doi Suthep Pui National Park, Mahidol Falls, 1250 m, 9 Feb 2003, *Palee 567* (CMU); *ibid.*, 1250 m, 14 Sep 2003, *Palee 667* (CMU); (CMU); Huay Mae Nai, 1200 m, 17 Aug 1988, *Maxwell 88-1008* (CMU); *ibid.*, 650 m, Mae Sa Botanical Garden, along Mae Sa Noi Stream, 8 Aug 1989, *Maxwell 89-1011* (CMU); Mae Lai village, Huay Kaew Subdistrict, c. 1175 m, 24 Oct 2005, *Palee 827* (CMU). **Nan.** Doi Phuoka National Park, Bua District, 1300 m, 22 Sep 1996, *Pooma 1373* (CMU, BKF). **Loei.** Phu Ruea district, Phu Luang Wildlife Sanctuary, 1560 m, 15 Oct 2009, *Middleton et al. 5160* (E); *ibid.*, 1475

m, 15 Oct 2009, *Middleton et al.* 5138 (E); Cultivated at Royal Botanic Garden Edinburgh in 21 Oct 2010 originally from Loei, Phu Ruea, Phu Luang Wildlife Sanctuary, 1505 m, 15 Oct 2009, collected as *Middleton et al.* 5152, accessioned as 20091940*A, vouchered as *Middleton* 5231 (E).

17. *Didymocarpus tristis* Craib

Bull. Misc. Inform. Kew 1926: 170 (1926); Pellegrin, Fl. Indo-Chine 4(5): 522 (1930); Barnett, Fl. Siam. 3(3): 218 (1962); Weber et al., Ann. Naturhist. Mus. Wien, B 102: 467 (2000); Burtt, Thai For. Bull., Bot. 29: 93 (2001). TYPE: *Unknown collector*, plant cultivated in Aberdeen which flowered for the first time in Oct 1925, from seeds collected by Dr. Kerr at Khao Soi Dao, Chanthaburi Province, 1400 m, on rocks (lectotype K [K000858323], designated here; isoelectotype ABD (no. 97, leaf only)). Fig. 6D.

Deciduous, perennial, epilithic herb. **Stems** simple, erect, sparsely covered with multicellular eglandular hairs, green, up to 36 cm tall, all parts of plant covered with 4-celled, conical, dark brown or red-brown, pigment glands. **Dry season leaves** ternate or 3-pseudoverticillate, anisophyllous; blades subcoriaceous, ovate, 1.5–2 cm long, 1 cm wide, apex acute, base shallowly cordate, upper surface silvery sericeous, lower surface very densely covered with pigment glands, venation obscure above, prominent underneath. **Rainy season leaves** ternate or 3-pseudoverticillate, anisophyllous; blades subcoriaceous, glossy dark green above, light green beneath, oblong to lanceolate, 4–15 cm long, 3–7 cm wide, apex acute, base obliquely, rounded to cordate, margins finely serrulate, upper surface densely covered with multicellular eglandular hairs, concealing the veins, lower surface sparsely covered with multicellular eglandular hairs and scattered pigment glands, venation pinnate, with 4–6 ascending secondary veins on each side, prominent beneath; petioles 4–9 cm long, slightly unequal in length, covered with indumentums as on leaves surface, light green. **Inflorescences** axillary, from the upper node, cymose, 15 cm long, many-flowered, axes light green-cream to light maroon; peduncles 6–14 cm long, densely covered with multicellular glandular hairs, light maroon; pedicels c. 0.5–1 cm long, sparsely covered with indumentum as on the peduncles, light green or light maroon. **Bracts** elliptic, c. 2.5–4 mm long, 1.5–2 mm wide, apex acute, maroon, glabrous, caducous. **Calyx** 5-lobed to the base, lobes lanceolate, not reflexed, glabrous, c. 3–4 mm long, 1 mm wide, apices obtuse, green-dull maroon. **Corolla** salverform, c. 2–2.5 cm long, glabrous, dark violet-dull reddish; tube c. 1.5–2 cm long, basal diameter of corolla tube 2 mm; anterior (lower) lip 3-lobed, lobes rounded, midlobe 5 mm long, 6 mm wide; posterior (upper) lip 2-lobed, rounded, 3 mm long, 3 mm wide. **Fertile stamens** inserted c. 1.2 cm from the base of the corolla tube; anthers oblong, c. 2 mm long, 1 mm wide, light violet-whitish glabrous; filaments c. 2.4 mm long, glabrous; staminodes 3, unequal, reduced to filaments, c. 1–2 mm long, glabrous. **Disc** cylindric, margin irregularly lobed, 1–2 mm long. **Ovary** glabrous, 1 cm long, light green; style c. 5 mm long, glabrous, light

green; stigma capitate, concave, cream. **Capsules** erect, 3 cm long. **Seeds** numerous, reniform, c. 0.27×0.13 mm, cell orientation straight.

Distribution. South-Eastern Thailand, only known from Chanthaburi.

Ecology. Moist, rugged, rocky and fog-covered areas in primary evergreen forest on granite and limestone bedrock.

Phenology. Flowering July–September, fruiting August–December.

Vernacular name. Ra Yab Mok (ระย้าหมอก).

Etymology. The specific epithet refers to the dull colour of the corolla.

Notes. *Didymocarpus tristis* differs from *D. insulsus* most obviously in the opposite rather than 3-pseudoverticillate leaves.

Specimens examined: THAILAND. **Chanthaburi.** Khao Kitchakut National Park, Khao Pra Bat, 600 m, 13 Aug 2000, *Phonsena* 2674 (BKF); *ibid.*, c. 1200 m, 24 Sep 2003, *Palee* 625 (CMU); *ibid.*, c. 920 m, 20 Jul 1999, *Newman* 927 (BKF, E); *ibid.*, c. 800 m, 27 Aug 2012, *Middleton et al.* 5673 (E); Khao Soi Dao, 1400 m, 14 Dec 1924, *Kerr* 9648 (K); Plant cultivated in Aberdeen from seeds collected from Khao Soi Dao, 1400 m, 14 Dec 1924 by Kerr 9648 (K).

18. *Didymocarpus wattianus* Craib

Gard. Chron. 72: 363 (1922) (*wattiana*); Craib, Gard. Chron. 75: 89 (1924) (*wattiana*); Barnett, Fl. Siam. 3(3): 218 (1962); Barnett, Dansk Bot. Ark. 20(2): 202 (1962); Weber et al., Ann. Naturhist. Mus. Wien, B 102: 468 (2000); Burtt, Thai For. Bull., Bot. 29: 93 (2001). TYPE: Specimen not found (the species was described from a plant which flowered in November 1922, grown by James Cromar Watt in Aberdeen from seed collected by Kerr without a known locality). NEOTYPE: Specimen collected from “Type plant” cultivated in Aberdeen, 31 Oct 1930 (neotype K [K000858325], designated here).

Deciduous, perennial, epilithic herb. **Stems** covered with multicellular eglandular hairs, c. 6–18 cm tall. **Leaves** opposite; blades subcoriaceous, dark green above, pale green beneath, oblong-elliptic, elliptic or ovate-lanceolate, to 9 cm long, to 5.5 cm wide, apex subacute to acuminate, base slightly obliquely cordate, margins denticulate, densely covered with whitish multicellular eglandular hairs and golden pigment glands, secondary with sparse indumentum as on the upper surface and sparse golden pigment glands; venation pinnate, sunken, with c. 12 ascending secondary veins on each side, prominent; petioles up to 8 cm long, with indumentum as on the stem. **Inflorescences** terminal, or from the axils of upper leaves, cymose, up to c. 7 cm long,

several flowered, axes covered with spreading, white multicellular glandular hairs and sparsely covered with one-celled, sessile, golden, pigment glands; peduncles 6 cm long; pedicels 5 mm long, with glandular, capitate hairs, sometimes with some pigment glands. **Bracts** 2, caducous, glabrous. **Flowers** several, pendulous in bud. **Calyx** campanulate, c. 1.9 cm long, c. 1 cm diameter, slightly asymmetric, glabrous, dark pink; shallowly 5-lobed, lobes triangular, c. 3 mm deep, 2 mm wide, apex rounded. **Corolla** c. 6–7 cm long, funnelform, glabrous, buds glossy, deep maroon-red, paler at anthesis; tube c. 4–4.5 cm long, base narrow, c. 3 mm diameter, widening at 2 cm from the base, throat c. 1 cm diameter; anterior (lower) lip 3-lobed, lobes rounded, c. 8 mm long, 9 mm wide; posterior (upper) lip 2-lobed, lobes, rounded, smaller than the anterior lobes, 5 mm long, 7 mm wide. **Fertile stamens** inserted at c. 3–3.5 cm above the base of the corolla; anthers oblong, c. 3 mm long, c. 2 mm wide, white-bearded; filaments glabrous, c. 1 cm long; staminodes 3, glabrous, reduce to filaments. **Disc** tubular, c. 2 mm long, margins irregular. **Ovary** cylindric, 4.5 cm long including stalk and style, light green, covered with multicellular glandular hairs; stigma peltate, concave, papillose. **Capsules** erect, c. 6 cm long. Pollen and seeds not studied.

Distribution. Northern Thailand, only known from Nan.

Ecology. Moist areas near streams in evergreen forest.

Phenology. Flowering September, fruiting October–December.

Vernacular name. Muang Dok Yai (ม่วงดอกใหญ่).

Etymology. The specific epithet honours James Cromar Watt, a contemporary of Craib and horticulturist in Aberdeen.

Notes. We have been unable to locate a specimen which is unequivocally original material. The neotype we have chosen states it is a collection from the same living plant in cultivation in Aberdeen but from several years after the protologue was published. No provenance information was given in the protologue but the seed that Kerr sent to Aberdeen could have been collected on Kerr's tour through northern Thailand to Nan via the mountainous district of Muang Pua in early 1921. Our evidence for this is that the cultivated neotype specimen is a close match to *Srisanga* 1708 (E) from Doi Phu Kha in Pua District. Barnett (1962a, 1962b) included in this species *Larsen* 490, collected on 11 Sep 1958 from Doi Suthep (Chiang Mai) at 1500 m. We have also been unable to locate this specimen.

Specimens examined: THAILAND. **Nan.** Doi Phu Kha National Park, Pua, 19°13'N 101°05'E, 25 Sep 2000, 1170 m, *Srisanga* 1708 (E). **Chiang Mai.** Doi Suthep-Pui National Park, Mahidol Falls, 1250 m, 8 Nov 1989, *Maxwell* 89-1377 (E).

ACKNOWLEDGEMENTS. Financial support from the Thailand Research Fund through the Royal Golden Jubilee Ph.D. Program (grant no. PHD/0188/2543) to Pranee Nangngam (formerly Pranee Palee) and Assoc. Prof. Dr. Vilaiwan Anusarnsunthorn is gratefully acknowledged. A part of this work was supported by the TRF/BIOTEC Special Program for Biodiversity Research and Training (grant no. BRT R_147011) along with financial support from the Faculty of Science, Naresuan University to the first author in 2013 to travel to the Royal Botanic Garden Edinburgh. We would like to thank the staff of all National Parks in Thailand which we visited and where we collected specimens for this study. Dr. J.F. Veldkamp (National Herbarium, Leiden, Netherlands) is thanked for correcting our Latin diagnoses. We thank the curators and staff at all herbaria for permission to examine their collections and for the loan of some specimens. We thank Dr. David Middleton for his comments on the manuscript. Finally, we would like to thank the reviewers for their suggestions.

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Appendix A. Identification list.

All collections examined are identified according to this species list:

- 1=*Didymocarpus aureoglandulosus* C.B.Clarke
- 2=*Didymocarpus bicolor* Craib
- 3=*Didymocarpus biserratus* Barnett
- 4=*Didymocarpus corchorifolius* Wall. ex DC.
- 5=*Didymocarpus dongrakensis* B.L.Burt
- 6=*Didymocarpus epithemoides* B.L.Burt
- 7=*Didymocarpus geesinkianus* B.L.Burt
- 8=*Didymocarpus inflatus* J.F.Maxwell & Nangngam
- 9=*Didymocarpus insulsus* Craib
- 10=*Didymocarpus jaesonensis* Nangngam & J.F.Maxwell
- 11=*Didymocarpus kerrii* Craib
- 12=*Didymocarpus megaphyllus* Barnett
- 13=*Didymocarpus newmanii* Barnett
- 14=*Didymocarpus ovatus* Barnett
- 15=*Didymocarpus payapensis* Nangngam & J.F.Maxwell
- 16=*Didymocarpus purpureopictus* Craib
- 17=*Didymocarpus tristis* Craib
- 18=*Didymocarpus wattianus* Craib

Adisai 925:18 — Geesink et al. 7416:7 (type) — BGO staff 7057:1, 9552:11, 4544:11, 6988:11, 9678:11 — C6744 accession no. 19683012:3, C8459 accession no. 19741960:3, C8460 accession no. 19741960:3, C3713 accession no. 19611998:3, C4304 E00628027:9, C4512 E00628030:9, C8069E00628026:9 — Carrot 4:8 — DE 191:3 — Dee Bunpheng 998:2 — E00421472 accession no. 20091940*A:16, E00628037 Kerr 206:14, E00628037 Ker 197:14, E00628037 Kerr 198:14 — Fukuoka and Ito T-34993:6, T-35034:9, T-34610:9 — Garret 441:11 — Geesink, Hattink, and Charoenphol 7416:7 (type).—Gen Murata et al.T-42099:9 — Giravatanapan 1:8 — Herb trip 1131:8 — Hosseus 220:1 (type) — Iwasuki & Fukuoka 4484:11 — Jatupol 08-409:2 — Kerr 1996:1 (type of syn.), 786:11 (type), 3443:11, 3215:12 (type), 13259:14 (type), 6277:15, 1414:16 (type), 9648:17 — Kunwasi 9:6 — Larsen 6258:3 (type) — Larsen 490:16 — Larsen & Hansen 4341:1, 4902:1, 4649:11 — Larsen & Larsen 34408:11 — Larsen, et al. 46087:4, 51:6, 10683:6 (type) — Maxwell 04-526:1, 92-496:1, 76-531:5 (type), 00-404:6, 04-490:8 (type), 00-391:9, 96-1093:10 (type), 02-284:11, 04-804:11, 89-1338:11, 89-1433:11, 94-986:11, 95-533:11, 95-1066:11, 07-718:15, 93-1098:15 (type), 88-1008:16, 89-1011:16, 89-1377:16, 99-82:16, 89-1377:18 — Middleton 5653:6 — Middleton et al. 4453:1, 5578:1, 5501:4, 5644:6, 5070:8, 5634:9, 5651:9, 5568:10, 4506:11, 4941:11, 5672:13, 5138:16, 5152:16, 5160:16, 5673:17 — Nangngam 2552:2 — Newman 926:14 (type), 927:17 — Niyomdham 3130:14 — O.T. 1252:9 — Palee 524:1, 549:1, 570:1, 701:1, 639:3, 662:4, 658:5, 603:6, 642:8 (type), 802:8, 839:8, 638:9, 645:9, 539:11, 550:11, 568:11, 668:11, 702:11, 741:11, 808:11, 686:12, 532:13, 622:13, 553:14, 664:14, 495:15, 641:15, 761:15, 815:15, 836:15, 871:15, 567:16, 667:16, 827:16, 543:17, 551:17, 625:17 — Palee & Tantana 752:12 — Palee & Toktang 668:11 — Panatkol 156:11 — Phengkhilai et al. 7188:11, 6736:15, 7188:11 — Phonsena 2675:13, 2674:17 — Pleoenchit 418:14 — Plernchit 245:12, 584:14 — Pooma 1373:16 — Pooma & Pattharahirantricin 7722:1 — Pooma et al. 7782:8 — Put 401:17 — RBG 19850475:2 — Roger 161:1 (type of syn.) — Sadakorn 588:11 — Sangkamathawee & Palee 499:15 — Shimizu et al. T8863:3, 19724:6 — Smitinand 11698:14 — Smitinand and

Sleumer 1012:1; 1870:3 (type); 10471:3 — Smitinand et al. 262:14 — Santisuk et al. 262:14 — Srisanga 251:1, 1534:11, 1708:18 — Suddee 169:9 — Suksathan 2693:11 — S. P. et al. 57663:9 — Tagawa et. al. 4852:14 — Takahashi and Tamura T-63384:9, T-62781:11 — Tamura T-6011:9 — van Beusekom and Charoenpol 1757:6, 1756:9 — Wai 1123:4 — Wallich 792:4 (type) — Watthana et al. 586:11, 484:12 — Williams et al. 1337:14, 1940:14 — Winit 1425:11, 749:15, 1164:15.

Appendix B. Index to names.

Numbers refer to the species number given in the text. Synonyms are in *italics* and new taxa are in **bold**:

Didymocarpus aureoglandulosus C.B.Clarke 1

Didymocarpus bicolor Craib 2

Didymocarpus biserratus Barnett 3

Didymocarpus corchorifolius Wall. ex DC. 4

Didymocarpus dongrakensis B.L.Burt 5

Didymocarpus epithemoides B.L.Burt 6

Didymocarpus geesinkianus B.L.Burt 7

Didymocarpus inflatus J.F.Maxwell & Nangngam 8

Didymocarpus insulsus Craib 9

Didymocarpus jaesonensis Nangngam & J.F.Maxwell 10

Didymocarpus kerrii Craib 11

Didymocarpus megaphyllus Barnett 12

Didymocarpus newmanii B.L.Burt 13

Didymocarpus ovatus Barnett 14

Didymocarpus payapensis Nangngam & J.F.Maxwell 15

Didymocarpus purpureopictus Craib 16

Didymocarpus rodgeri W.W.Sm. 1

Didymocarpus rodgeri W.W.Sm. var. *siamensis* W.W.Sm. 1

Didymocarpus siamensis Barnett 3

Didymocarpus squamosa Craib 11

Didymocarpus tristis Craib 17

Didymocarpus wattianus Craib 18

A new species of *Monoon* (Annonaceae) from Brunei

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ABSTRACT. *Monoon bathrantherum* I.M.Turner is newly described. It is only known from Brunei on the island of Borneo and is notable for bearing reproductive structures on branched inflorescences confined to the base of the trunk.

Keywords. Annonaceae, Borneo, *Enicosanthum*, Malesia, *Monoon bathrantherum*, *Polyalthia*

Introduction

The genus *Monoon* was originally described by Miquel (1865). He included a rather disparate selection of species but the majority were considered allied to *Polyalthia*. Bentham and Hooker (1867) reduced *Monoon* to a section of *Polyalthia* which is where it has stayed, and been rather neglected, until being resurrected recently (Xue et al. 2012) as part of the shake-up of *Polyalthia* based on molecular and morphological analyses. The remodelled *Monoon* includes *Enicosanthum* Becc., *Woodiellantha* Rauschert and *Cleistopetalum* H.Okada and their synonyms as well as *Polyalthia* section *Monoon*. The genus thus consists of some 60 species ranging from India to Australia.

The new species here described would certainly have been placed in *Enicosanthum* until recently as it has the imbricate perianth aestivation that distinguished the genus before molecular evidence indicated that this character was not sufficient to maintain a distinction from the rest of *Monoon*. The most remarkable feature of the new species is the presence of basal twiggy inflorescences.

***Monoon bathrantherum* I.M.Turner, sp. nov.**

The new species bears reproductive structures on branched inflorescences confined to the base of the trunk similar to *Monoon congregatum* (King) B.Xue & R.M.K.Saunders of the Malay Peninsula but differs in having longer inflorescence axes (to 20 cm versus 6 cm in *M. congregatum*) and less thick and fleshy petals.

TYPE: *Sands 5749*, Brunei, Belait, Labi, Rampayoh, Rampayoh river valley c. 2.5 km from the Labi Road, 8 July 1993 (holo K[×2] (barcode nos. K000582145 and K000582146); iso BRUN [×2] (sheet nos. B 004 226, B 004 227). Fig. 1.

Tree to 20 m or more tall, 20 cm dbh or more. Twigs drying brown, latticed or longitudinally wrinkled, youngest parts covered with a short dense brown tomentum giving a soft feel to the touch. **Leaves** subcoriaceous, drying brown above, grey-green

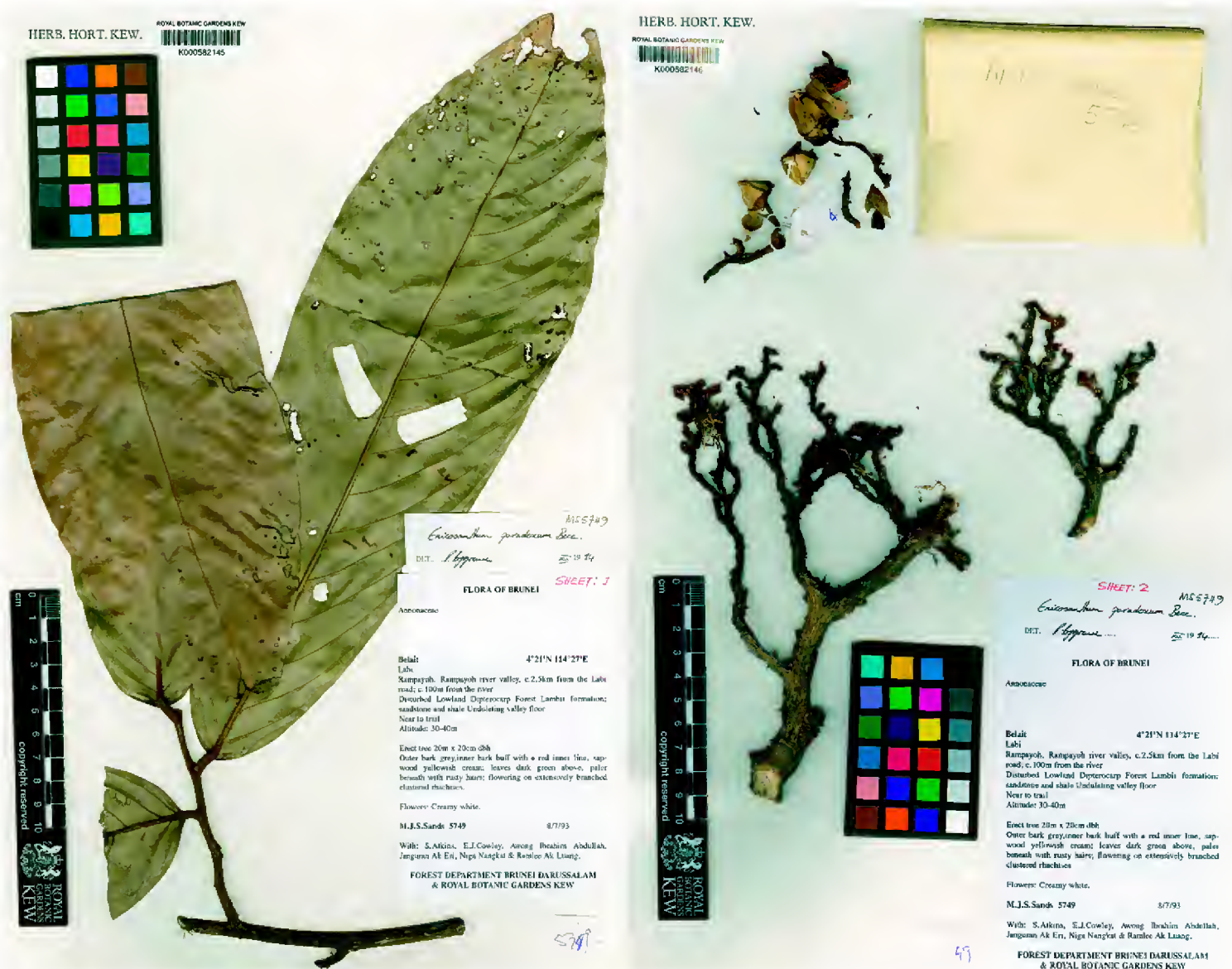


Fig. 1. Photograph of Sands 5749, the holotype (mounted on two sheets) of *Monoon bathrantherum* I.M. Turner. Reproduced with the kind permission of the Director and the Board of Trustees, Royal Botanic Gardens, Kew. © Royal Botanic Gardens, Kew.

below, some hairs along midrib, otherwise glabrous above, short hairs on midrib and major nerves below, lamina lanceolate to oblanceolate, $34\text{--}36 \times 11\text{--}12$ cm, lateral nerves, 21–24 pairs, arching forward and looping indistinctly near the margin, tertiary venation scalariform. Petiole c. 10 mm long, 4 mm in diameter, densely short brown hairy. **Inflorescences** of robust, much-branched leafless twigs, to at least 20 cm long, arising from the base of the main trunk. **Flower** pedicel to 6 cm long, 1.5 mm thick, drying brown, covered in a dense short brown tomentum, medial bract ovate, c. 7×3 mm, apex acute, covered in dense short tomentum abaxially, glabrous adaxially; flower in bud broadly conical with a flat base, sepals valvate, chartaceous, ovate, c. 14×11 mm, apex acute, densely covered in brown tomentum, outer petals imbricate in bud, ovate, c. $5\text{--}9 \times 1.8\text{--}2$ cm, dense, very short brown hairy outside with faint longitudinal lines, inside more sparsely hairy, inner petals slightly shorter and narrower than outer petals, centre of longitudinal edges folded inwards to middle and apex incurved giving a hooded appearance to the distal portion, torus more or less flat with erect brown hairs, stamens many, c. 4 mm long, connective apex with white hairs, carpels many c. 4 mm long, brown hairy. **Monocarps** stipitate, ellipsoidal, c. 5×2 cm, beaked, dark brown hairy.

Other specimens examined: BRUNEI DARUSSALAM. **Belait.** Labi, Mendaram, trail to Wasai Kadir, 4 Apr 1996, *Said BRUN 16181* (BRUN: sheet no. B 004 229; K), Wong Kadir, trail to Wasai Wong Kadir, 15 Dec 1997, *Ariffin & al. BRUN 18723* (BRUN: sheet no. B 004 230), Teraja, first waterfall, 28 Mar 2006, *Mohd. Ariffin & al. BRUN 21689* (BRUN: sheet no. B 004 228).

Etymology. The specific epithet is derived from Greek: *bathro-* = basal, *antheros* = flower and reflects the basiflory exhibited by the species.

Notes. Cauliflory is a relatively common feature in the Annonaceae, and occurs quite frequently in *Monoon*. The restriction of reproductive structures to the base of the trunk is a relatively rare phenomenon in trees but again it is found in the Annonaceae and is observed in *Monoon* in species such as *M. hypogaeum* (King) B.Xue & R.M.K.Saunders which also occurs in Borneo. *Monoon hypogaeum* is unlikely to be confused with *M. bathrantherum* as its inflorescences have long, slender, apparently flexible, axes compared to the relatively stout and stiff axes of the latter. The flowers of *M. hypogaeum* are smaller (petals to only 2 cm long) and the monocarps are distinctively fusiform.

Vegetatively *M. bathrantherum* is like the Bornean *M. erianthoides* (Airy Shaw) B.Xue & R.M.K.Saunders, but the branched inflorescences and the stipitate monocarps (sessile in *M. erianthoides*) readily distinguish it.

ACKNOWLEDGEMENTS. Thanks to Jacqueline Henrot (L) and Joffre b. Hj. Ali Ahmad (BRUN) for facilitating access to photographs of the material in BRUN. I.M. Turner is a Research Associate of the Royal Botanic Gardens Kew and Singapore Botanic Gardens.

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 Xue, B., Su, Y.C.F., Thomas, D.C. & Saunders, R.M.K. (2012) Pruning the polyphyletic genus *Polyalthia* (Annonaceae) and resurrecting the genus *Monoon*. *Taxon* 61: 1021–1039.

The collection and storage of plant material for DNA extraction: The Teabag Method

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ABSTRACT. Silica gel has become the most common instrument for preserving leaf material in the field for future DNA extraction. This has generally involved leaf material being placed in silica gel in zip-lock type bags. Although effective it often requires a large amount of silica gel and large number of plastic bags to be taken into the field, something which is problematic during long field trips to remote areas. It also has the disadvantage that if the silica gel becomes hydrated or the plant material damp, replacement of the silica gel is difficult and can result in contamination. An alternative method using empty teabags avoids the need to carry large amounts of silica gel and plastic bags into the field and reduces the difficulty of replacing hydrated silica gel during fieldwork and longer term institutional storage.

Keywords. Collection, DNA, plant, silica gel, storage, teabag

Introduction

The success of global initiatives such as the Angiosperm Phylogeny Group (Angiosperm Phylogeny Group 1998; Angiosperm Phylogeny Group II 2003; Angiosperm Phylogeny Group III 2009) and the Barcode of life (Hollingsworth et al. 2011) have relied very much on high levels of species sampling and the availability of suitable material for DNA extraction. Taxa from temperate zones, botanic gardens or that are cultivated are often well sampled but species found in the tropics, in particular in more remote areas, are poorly represented (Harris 1993). To address this problem, extraction of material from herbarium material suitable for DNA analysis has been investigated with varying degrees of success depending on age, preservation methods and storage conditions (e.g. Lister et al. 2008; Liston et al. 1990; Andreassen et al. 2009; Rogers & Bendich 1985; Sarkinen et al. in press). This practice, however, has raised concern from collection curators about the destructive nature of this sampling from often irreplaceable herbarium material. Extraction has also been problematic from herbarium specimens pressed in spirit or poisoned – a common practice in South

East Asia. The collection of plant material dried in silica gel, in addition to herbarium material, is now a common practice and helps avoid the difficulties of DNA extraction from herbarium material.

Chase & Hills (1991) suggested the collection of about 4–6 grams of fresh leaf material torn into pieces not exceeding 2 cm² and then placed into a zip-lock type sealable plastic bag with silica gel at a ratio of not less than 10 to 1. This is considered a highly effective method of drying material and minimising DNA degradation.

The storage of material in zip-lock bags appears effective but requires a large amount of silica gel and plastic bags to be taken into the field, something which can be problematic during long field trips to remote areas. It also has the disadvantage that if the silica gel becomes hydrated (a small hole in the bag will cause hydration in tropical environments) the replacement of the silica gel is difficult and its reuse can result in contamination. This paper summarizes a method which is becoming more widely used but currently unpublished. It should be useful to researchers wishing to refine their field practices.

Methods

An alternative method of drying and storing plant material for DNA extraction uses empty teabags such as those that are widely available in supermarkets and specialist tea shops. Instead of placing the material in silica gel in a sealable plastic bag, as suggested by Chase & Hills (1991), the material is placed inside the teabag with a collector label placed against the wall of the bag so that it is easily legible (Fig. 1A) and sealed (usually by folding the top over). The teabag is then placed in an airtight container and completely submerged in silica gel until completely dry (Fig. 1B). The container is shaken frequently over the first day to make sure dry silica gel is always in close contact with the plant material. Once the material is completely dry, the teabag can then be removed from the silica gel and placed in an airtight container which has a fresh layer of silica gel at its base (Fig. 1C) for longer term storage. This silica gel layer can be easily replaced if it becomes hydrated.



Fig. 1. **A.** Ripped leaf material placed in teabag with internal paper label. **B.** Teabag submerged in silica gel (regularly shaken). **C.** Longer term storage of teabags in sealable container with layer of silica gel at base. (Photos: P. Wilkie)

Results

In the field, plant material placed in teabags has been found to dry within the same time scale as material placed directly into silica gel in zip-lock bags. The amount of silica gel and zip-lock bags needed to be taken into the field has been reduced significantly and it has been much easier to replace hydrated silica gel in the field.

Material collected and stored in this manner over the past seven years at the Royal Botanic Garden Edinburgh appears equally effective as material stored using zip-lock bags at providing non-degraded DNA. Although not statistically rigorous, parallel QIAextractor (Qiagen) extraction of material from the same plant accession collected three years previously using both traditional and teabag collection and storage methods provided equivalent quantities and qualities of DNA, as assessed by gel electrophoresis and spectrophotometry. Polymerase chain reaction amplification of plastid loci *trnL* and *rbcL* was also confirmed. No contamination of material between collections has been recorded, indeed it is probable that this method reduces this risk, especially when having to replace silica gel, as the plant material remains contained within the teabag at all times.

The teabag method has simplified the management of collections during longer term institutional storage and has proven particularly useful in tropical environments which have to deal with very high ambient humidity and thus more regular changing of silica gel.

Discussion

This short paper suggests a modified method of collecting leaf material for subsequent DNA extraction. Much of the information gathered has been from our own experience, with a range of researchers using this method in the field in different continents over the past few years. Some variations to this method can be found on the web, such as the use of envelopes and coffee filters (<http://evol.mcmaster.ca/~brian/evoldir/Answers/Leaf.Preservation.answers>). The most obvious benefit to the field botanist is the reduced amount of silica gel and plastic bags needing to be transported to and from the field. In tropical climates the ability to easily change the silica gel has also been an important improvement, as it has been found that zip-lock bags are not 100% airtight (particularly when silica grains get into the mechanism), which can lead to rehydration of plant material. No obvious difference in efficacy of the material for DNA extraction has been noticed compared to the zip-lock bag method although we acknowledge that our trials did not provide statistical support for this observation. Indeed we hope that this paper may generate further investigations and publications on this topic.

Of equal importance to the long term preservation of plant material suitable for DNA extraction is the environmental conditions in which the desiccated material (be it in a teabag or zip-lock bag) is stored over the long term. As noted by Hollingsworth et al. (2011) there is a need for guidelines on the optimum storage conditions for

desiccated material, though it appears that the dryer, colder and more stable the environment, the less likely the DNA is to degrade.

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Studies in Malesian Gentianaceae, V. The *Fagraea* complex in Borneo: New generic assignments and recombinations

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ABSTRACT. A new classification of the *Fagraea* complex (Gentianaceae) based on recent molecular studies and taxonomic considerations now recognises the genera *Cyrtophyllum*, *Fagraea* in the strict sense, *Limahlania*, *Picrophloeus*, and *Utania*. The Bornean species of this complex are listed following the new perspective and the remaining necessary new combinations (seven, in *Utania*) are made.

Keywords. Borneo, *Cyrtophyllum*, *Fagraea*, Gentianaceae, *Limahlania*, *Picrophloeus*, *Utania*

Introduction

Wong & Sugau (1996) revised the Bornean species of the *Fagraea* Thunb. complex. In their work, they reviewed a number of species limits that had previously been masked by the broader concepts adopted by Leenhouts (1962b), and revived a number of names that had been enumerated or described by Cammerloher (1923) and others. In addition, a number of species were also newly recognised. Subsequently, Sugumaran & Wong (2012) demonstrated good support from molecular evidence for reasonably clear lineages that could be identified with genera within the *Fagraea* Complex. Their new classification recognised *Cyrtophyllum* Reinw., *Fagraea* (in the strict sense), *Limahlania* K.M.Wong & M.Sugumaran, *Picrophloeus* Blume, and *Utania* G.Don.

Genera and sections

Of the three sections of *Fagraea* recognised by Leenhouts (1962b), *F.* section *Cyrtophyllum* (Reinw.) Blume (Blume 1838) is considered to have included two distinct groups, which Wong & Sugau (1996) simply referred to as the “*F. fragrans* complex” (axillary inflorescences) and “*F. elliptica* complex” (terminal inflorescences). There are further differences (e.g., plant architecture) and these groups are now recognised as

Cyrtophyllum (five species, revised by Wong & Sugumaran 2012b) and *Picrophloeus* (four species: Wong 2012).

All species of *F.* section *Fagraea* (*sensu* Leenhouts 1962b) remain in *Fagraea sensu stricto*, except for *F. crenulata* Maingay ex Clarke which was transferred to the new monospecific genus, *Limahlania* K.M.Wong & M.Sugumaran (Wong & Sugumaran 2012a). The species of *F.* section *Racemosae* Benth. (Bentham 1856), with a rather distinct inflorescence structure in which the elongate panicle bears condensed branches that are much shorter than the rachis (in the other genera of this complex, the basal cyme branches are similar to the rachis in length), are transferred to the genus *Utania* G.Don.

Taxonomic assignment of Bornean species in the *Fagraea* Complex

Here we outline the generic designation of 43 known Bornean species from the *Fagraea* Complex according to this new classification. Species distributions have been given in the Bornean enumeration of Wong & Sugau (1996) except that of the newly described *Cyrtophyllum minutiflorum* K.M.Wong, in Wong & Sugumaran (2012b).

CYRTOPHYLLUM (4 spp.)

Fagraea caudata Ridl. = *Cyrtophyllum caudatum* (Ridl.) K.M.Wong, Gard. Bull. Singapore 64: 499 (2012).

Fagraea fragrans Roxb. = *Cyrtophyllum fragrans* (Roxb.) DC., Prodrum 9: 31 (1845).

Fagraea gigantea Ridl. = *Cyrtophyllum giganteum* (Ridl.) Ridl., Fl. Malay Penins. 2: 421 (1923).

Cyrtophyllum minutiflorum K.M.Wong, Gard. Bull. Singapore 64: 507 (2012).

FAGRAEA (27 spp.)

Fagraea acutibracteata K.M.Wong & Sugau, Sandakania 8: 49 (1996).

Fagraea auriculata Jack, Malayan Misc. 2, 7: 82 (1822).

Fagraea blumei G.Don, Gen. Hist. 4: 69 (1837) (in Don 1838).

Fagraea borneensis Scheff., Flora 52: 309 (1869).

Fagraea carnosae Jack, Malayan Misc. 2, 7: 81 (1822).

Fagraea dulitensis K.M.Wong & Sugau, Sandakania 8: 59 (1996).

Fagraea floribunda K.M.Wong & Sugau, Sandakania 8: 62 (1996).

Fagraea havilandii K.M.Wong & Sugau, Sandakania 8: 64 (1996).

Fagraea iliasii K.M.Wong & Sugau, Sandakania 8: 66 (1996).

Fagraea involucrata Merrill, J. Straits Branch Roy. Asiat. Soc. 77: 233 (1917).

Fagraea kalimantanensis (Leenh.) K.M.Wong & Sugau, Sandakania 8: 69 (1996).

Fagraea kinabaluensis K.M.Wong & Sugau, Sandakania 8: 69 (1996).

Fagraea kuminii K.M.Wong & Sugau, Sandakania 8: 71 (1996).

Fagraea littoralis Blume var. *borneensis* K.M.Wong & Sugau, Sandakania 8: 73 (1996).

Fagraea longipetiolata K.M.Wong & Sugau, Sandakania 8: 75 (1996).

Fagraea macroscypha Baker, Kew Bull.: 25 (1896).

Fagraea megalantha K.M.Wong & Sugau, Sandakania 8: 77 (1996).

Fagraea oblonga King & Gamble, J. Asiat. Soc. Bengal 74, 2: 612 (1908).

Fagraea oreophila K.M.Wong & Sugau, Sandakania 8: 78 (1996).

Fagraea rarissima K.M.Wong & Sugau, Sandakania 8: 82 (1996).

Fagraea renae K.M.Wong & Sugau, Sandakania 8: 82 (1996).

Fagraea resinosa Leenh., Bull. Jard. Bot. État Bruxelles 32: 429 (1962a).

Fagraea ridleyi King & Gamble, J. Asiat. Soc. Bengal 74, 2: 612 (1908).

Fagraea splendens Blume, Mus. Bot. 1: 168 (1850).

Fagraea stonei K.M.Wong & Sugau, Sandakania 8: 88 (1996).

Fagraea tuyukii K.M.Wong & Sugau, Sandakania 8: 90 (1996).

Fagraea sp. A., K.M.Wong & Sugau, Sandakania 8: 92 (1996).

LIMAHLANIA (1 sp.)

Fagraea crenulata Maingay ex Clarke in Hooker f., Fl. Brit. India 4 (1883) 83 = *Limahlania crenulata* (Maingay ex Clarke) K.M.Wong & M.Sugumaran, Gard. Bull. Singapore 64: 492 (2012).

PICROPHLOEUS (4 spp.)

Fagraea belukar K.M.Wong & Sugau = *Picrophloeus belukar* (K.M.Wong & Sugau) K.M.Wong, Gard. Bull. Singapore 64: 513 (2012).

Fagraea collina K.M.Wong & Sugau = *Picrophloeus collinus* (K.M.Wong & Sugau) K.M.Wong, Gard. Bull. Singapore 64: 514 (2012).

Fagraea elliptica auctt. incl. Wong & Sugau, Sandakania 8 (1996) 21 = *Picrophloeus javanensis* Blume, Bijdr. Fl. Ned. Ind. 16: 1020 (1826).

Fagraea rugulosa K.M.Wong & Sugau = *Picrophloeus rugulosus* (K.M.Wong & Sugau) K.M.Wong, Gard. Bull. Singapore 64: 520 (2012).

UTANIA (7 spp.)

Fagraea cuspidata Blume, Mus. Bot. 1: 170 (1850); Wong & Sugau, Sandakania 8: 28, f. 9 (1996) = *Utania cuspidata* (Blume) K.M.Wong, M.Sugumaran & Sugau, **comb. nov.**

TYPE: *Blume*, s.n., Borneo, Tanjong Java (iso L).

Fagraea montana K.M.Wong & Sugau, Sandakania 8: 31, f. 10 (1996) = *Utania montana* (K.M.Wong & Sugau) K.M.Wong, M.Sugumaran & Sugau, **comb. nov.**
TYPE: *Aban SAN 50722*, Sabah, Ranau, Mamut, copper mining area (holo SAN; iso K, L).

Fagraea philippinensis K.M.Wong & Sugau, Sandakania 8: 35, f. 12 (1996) = *Utania philippinensis* (K.M.Wong & Sugau) K.M.Wong, M.Sugumaran & Sugau, **comb. nov.**

TYPE: *Ahern's Coll. For. Bur. 3270*, Philippines, Luzon, Rizal (holo K).

Fagraea spicata Baker, Kew Bull. (1896) 25; Wong & Sugau, Sandakania 8: 38 (1996) = *Utania spicata* (Baker) K.M.Wong, M.Sugumaran & Sugau, **comb. nov.**

TYPE: *Creagh*, s.n., British North Borneo, east coast (holo K).

Fagraea stenophylla Becc. ex Merrill, J. Straits Branch Roy. Asiat. Soc. 77: 236 (1917); Wong & Sugau, Sandakania 8: 38, f. 13 (1996) = *Utania stenophylla* (Becc. ex Merrill) K.M.Wong, M.Sugumaran & Sugau, **comb. nov.**

TYPE: *Native Coll. Bur. Sci.* 2828, Sarawak, Upper Baram, Selungo (iso A, UC).

Fagraea teysmannii Cammerloher, Bull. Jard. Bot. Buitenzorg, ser. 3, 5: 314, f. 3 (1923); Wong & Sugau, Sandakania 8 (1996) 40 = *Utania teysmannii* (Cammerloher) K.M.Wong, M.Sugumaran & Sugau, **comb. nov.**

TYPE: *Teysmann*, s.n., Karimata, Soengai Tajan (lecto L; chosen by Wong & Sugau 1996).

Fagraea volubilis Wall. in Roxb., Fl. Ind. 2: 36 (1824); Wong & Sugau, Sandakania 8: 40 (1996) = *Utania volubilis* (Wall.) M.Sugumaran, Gard. Bull. Singapore 64: 493 (2012).

TYPE: *Jack*, E. Bencoolen (sheet marked “1600. E. Bencoolen” on bottom left) (holo K-W).

Fagraea volubilis var. *microcalyx* K.M.Wong & Sugau, Sandakania 8: 43, f. 14 (1996) = *Utania volubilis* var. *microcalyx* (K.M.Wong & Sugau) K.M.Wong, M.Sugumaran & Sugau, **comb. nov.**

TYPE: *Burley, Tukirin et al.* 372, Kalimantan, 5 km NE of Haruwu village (holo KEP; iso A, BO).

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***Marsdenia maingayi* (Apocynaceae: Asclepiadoideae), a rare rainforest woody climber rediscovered in Singapore**

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ABSTRACT. *Marsdenia maingayi*, a rare rainforest climber previously thought to be extinct in Singapore, was rediscovered in the vicinity of MacRitchie Reservoir, Central Catchment Nature Reserve in July 2012. This is the second sighting of the taxon in Singapore since it was first collected in Changi in 1885—more than 120 years later. Based on this recent discovery, additional observations on the taxon are provided here and the conservation status of this species is revised to Critically Endangered for Singapore. *Marsdenia maingayi* is lectotypified here.

Keywords. Apocynaceae, Asclepiadoideae, Central Catchment Nature Reserve, extinct, lectotypification, MacRitchie Reservoir Park, *Marsdenia maingayi*, rediscovery, *Stephanotis maingayi*

Introduction

Marsdenia R.Br. (Apocynaceae, Asclepiadoideae) is a genus consisting of about 200 species of twining woody climbers and subshrubs distributed worldwide in the warm tropical and subtropical regions (Mabberley 2008). Robert Brown dedicated the genus to the First Secretary of the British Admiralty, William Marsden (1754–1836), who was an authority on Sumatran history and an avid promoter of botany (Brown 1810). *Marsdenia maingayi* (Hook.f.) P.I.Forst. is an elusive rainforest woody climber endemic to the Malay Peninsula (Peninsular Malaysia and Singapore). It has only been recorded five times (four records from Peninsular Malaysia, and once from Singapore) based on a survey of herbarium materials available in the Herbarium of the

Royal Botanic Gardens, Kew (K), Forest Research Institute Malaysia, Kepong (KEP), and Singapore Botanic Gardens (SING) (herbarium acronym follows Thiers 2013). The species was initially described as *Stephanotis maingayi* Hook.f. (Hooker 1885), based on a collection from Melaka made by Maingay on 23 June 1865 or 1866. Forster (1995a) later recombined it as *Marsdenia maingayi* after conclusive findings based on morphological characters revealed that *Stephanotis* Thouars and *Marsdenia* were taxonomically congeneric (Forster 1995b).

The first collection of the species in Singapore was made by Hullett from Changi in 1885 (Gamble 1908; Ridley 1923). Ridley (1923), however, could not find any living material in Singapore or Peninsular Malaysia and remarked that the species could have gone extinct. As the species was not sighted in Singapore in the more than a century since Hullett's discovery this prompted Tan et al. (2008) and Chong et al. (2009) to list the taxon as Presumed Nationally Extinct in Singapore. However, in 2012 we rediscovered this flowering climber in the vicinity of MacRitchie Reservoir Park and report it here. The conservation status for the species in Singapore is revised, based on Davison (2008).

The IUCN conservation status of *Marsdenia maingayi* is also assessed throughout its range using GeoCAT (Bachman et al. 2011), an IUCN Red List (IUCN 2001) compliant software that generates the IUCN threat categories based on (i) extent of occurrence (EOO), and (ii) area of occurrence (AOO). Data used for the assessment here are based on herbarium records that are represented in three herbaria, i.e., K, KEP and SING.

The discovery at MacRitchie Reservoir Park

The *Marsdenia maingayi* specimen discovered in the vicinity of MacRitchie Reservoir is a vigorous woody climber found just beside a jogging trail, along the forest margin (Fig. 1). The climber was undetected initially, even though the first author made regular visits to the park, as it was growing high up in the tree canopy at about 8–10 m above ground. However, a recent tree fall at the spot eventually brought parts of the climber down, closer to the ground. Subsequently, the climber flowered, and was spotted by the first author in July 2012, who collected a small flowering specimen and forwarded it to SING for identification. The newly collected material was eventually found to match the Hullett collection from Changi. Furthermore, it also matched the type specimens (*Maingay 1731 / Kew Distrib. No. 1112*) in the Herbarium of the Royal Botanic Gardens, Kew (K). Upon ascertaining the identity and rarity of this plant, a second visit to the site was made in August 2012 to properly document, observe and make a herbarium collection of the specimen to be deposited at SING, along with duplicate material of this rare species.

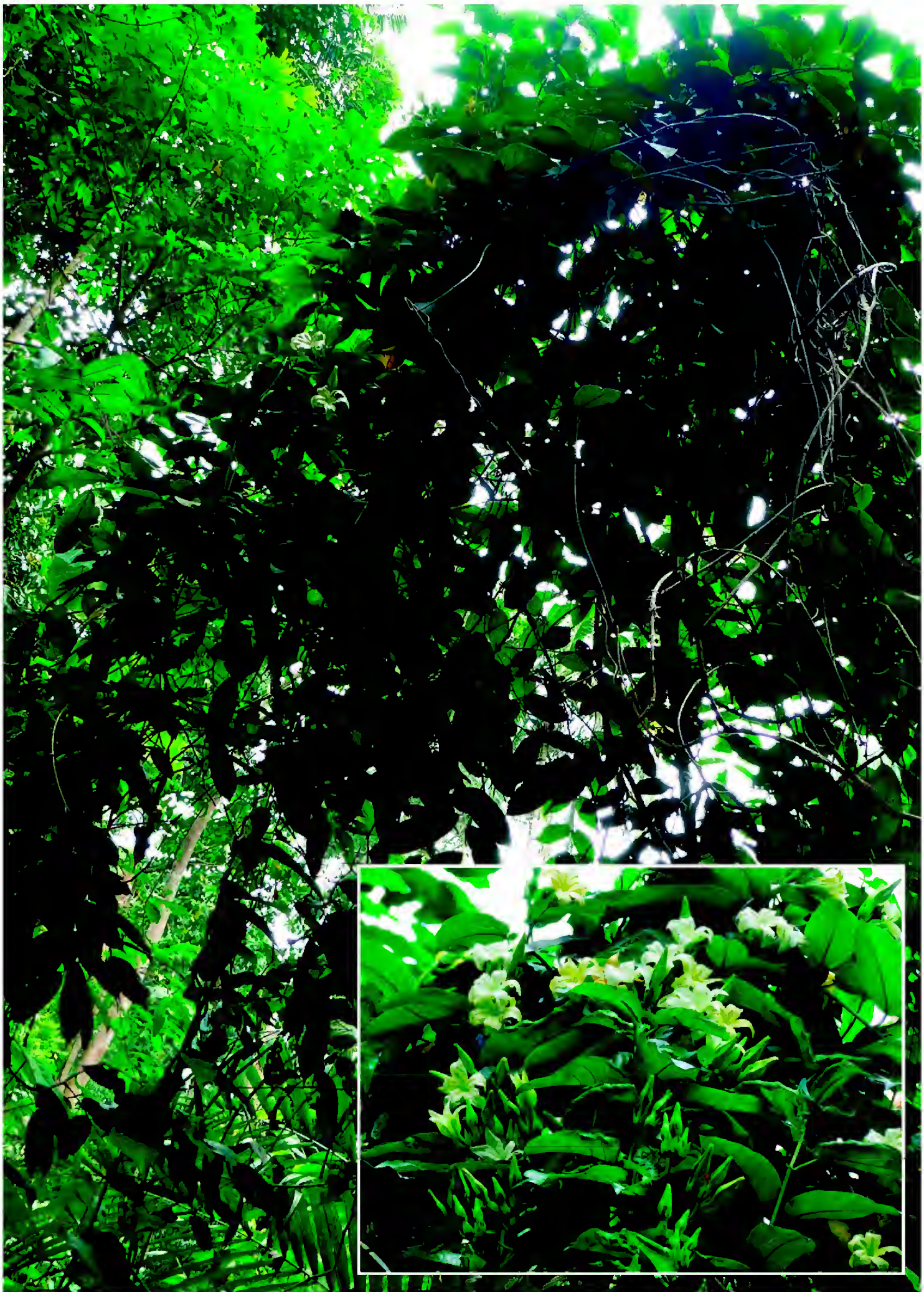


Fig.1. The vigorous MacRitchie specimen of *Marsdenia maingayi* growing along the forest margin, beside a jogging track (Photo: C.K. Yeo). *Inset:* Gregarious flowering observed in July 2012. (Photo: Y.S. Yeoh)

Taxonomy

Marsdenia maingayi (Hook.f.) P.I.Forst., Austral. Syst. Bot. 8(5): 700 (1995). — *Stephanotis maingayi* Hook.f., Fl. Brit. India 4: 39 (1885); Gamble, J. Asiat. Soc. Bengal 74(2): 550 (1908); Ridley, Fl. Mal. Pen. 2: 389 (1923). TYPE: *Maingay 1731*, Peninsular Malaysia, Melaka, 23 Jun 1865–1866 (*Kew Distrib. No. 1112*) (lecto K! barcode K000821736, designated here; isolecto K! barcode K000821737). Fig. 2.

Robust twining woody climber, exudate clear. Indumentum of pale yellow-brown erect unicellular eglandular trichomes on most parts. **Stems** woody, twining, cylindrical, 2–4(–5) mm wide, sparsely pubescent when young, usually glabrous on older parts, older parts lenticellate; internodes (9.2–)10–15.5(–18.5) cm long. Petiole (1.8–)2–2.5(–3) cm long, 1–1.5 mm wide, sparsely pubescent. **Leaf lamina** elliptic to ovate, (8–)9.5–11(–15) cm long, (4.6–)5.5–5.8(–9.5) cm wide, chartaceous; colleters on adaxial surface of the lamina base up to 9, conical, pale to dark brown; lamina base cordate; apex acute to acuminate; venation pinnate, midrib flat to sunken and minutely puberulent on upper surface, prominent and puberulent on lower surface; secondary veins 6–9(–11) pairs, flat and subglabrous on upper surface, prominent and sparsely puberulent on lower surface; tertiary venation reticulate. **Inflorescence** extra-axillary, racemiform, 2.5–6 cm long; peduncles 2.5–5 cm long, 1.7–2 mm wide, sparsely pubescent; bracts narrowly lanceolate, 5–8 mm long, outside sparsely pubescent, inside glabrous. **Flowers** 2–5 per inflorescence, 7.5–9 cm long, 7–8 cm wide; pedicels 2–3.5 cm long, 1–1.8 mm wide, sparsely pubescent. Sepals lanceolate, 1.4–2.4 cm long, 2–3 mm wide at base, 5–10 mm at the widest portion narrowing towards the apex; outside sparsely pubescent, inside glabrous. **Corolla** salver-shaped with right-contorted lobes, white turning pale yellow, then yellow-orange; tube 1.8–2.7 cm long, 4–5.5 mm wide at the mid portion, 4–7 mm wide at throat, outside sparsely pubescent, inside glabrous on most of the upper parts except for narrow V-shaped patches of retrose trichomes around the base of the staminal column; lobes 5, lanceolate, 2–3.2 cm long, 7–11 mm wide, outside sparsely pubescent, inside glabrous. **Staminal corona** 8–9 mm long, up to 5 mm wide, tips overtopping style-head. **Staminal column** up to 12 mm long, up to 5 mm wide; anther appendages with an irregularly hyaline-membranous apex surrounding the style-head, ovate, 4–5 mm long, up to 2 mm wide; alar fissure c. 4 mm long. **Style-head** umbonate, c. 4 mm long, c. 2 mm wide. **Pollinarium** c. 1.2 mm long, c. 1.5 mm wide; pollinium ellipsoid, c. 1 mm long, c. 0.3 mm wide; corpusculum ovate, c. 0.8 mm long, c. 0.7 mm wide; caudicles c. 0.3 mm long, c. 0.1 mm wide. **Fruit** a single follicle, cylindrical-oblong, c. 24.6 cm long, c. 4 cm wide; seeds many, ovate, 1.3–1.5 cm long, 0.7–0.9 cm wide, comose at germinating end, coma c. 8 cm long, golden brown.

Distribution. Endemic to the Malay Peninsula (Peninsular Malaysia and Singapore) (Fig. 3).

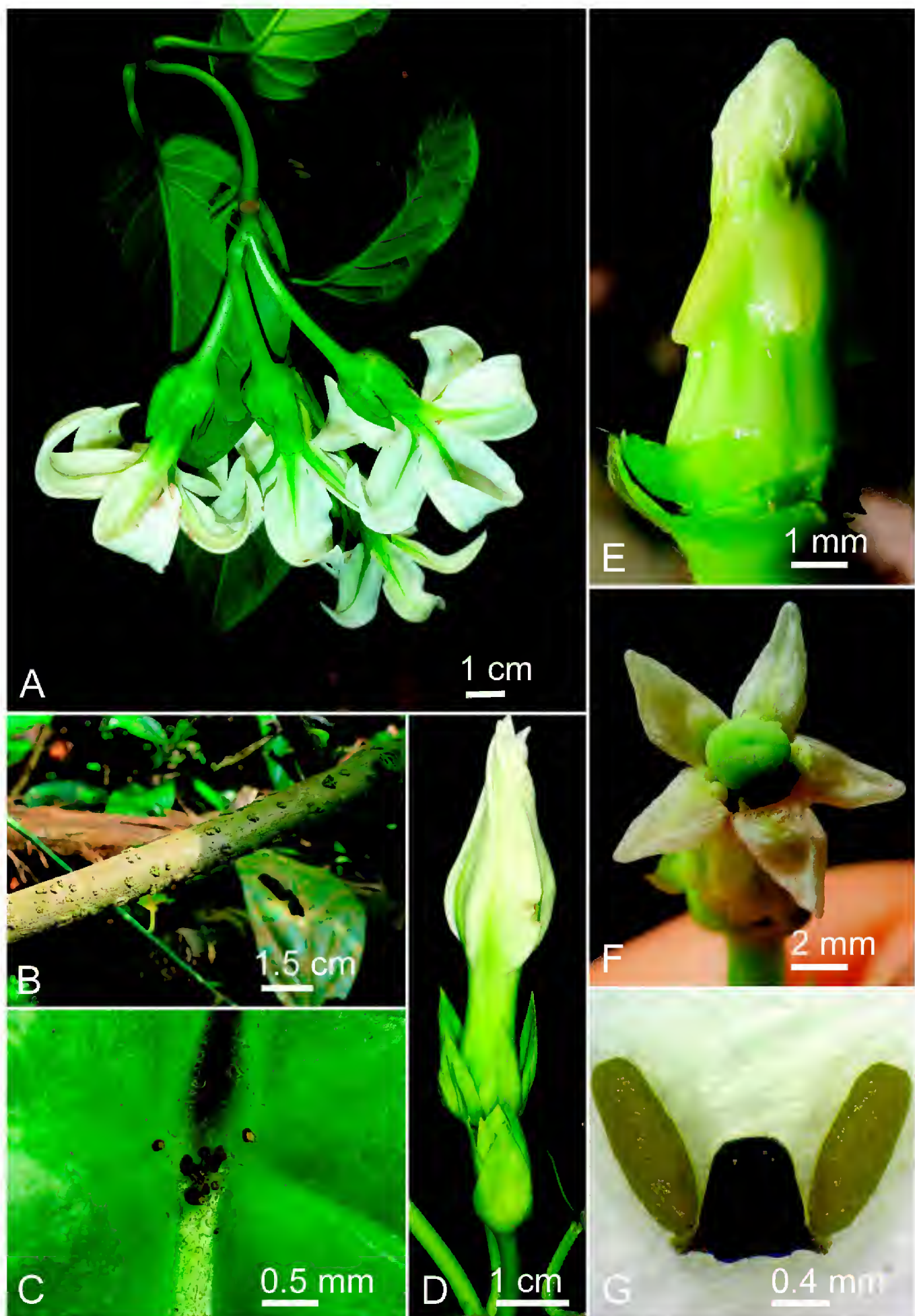


Fig. 2. *Marsdenia maingayi* (Hook.f.) P.I. Forst. **A.** The showy pendulous inflorescence with salver shaped flowers. **B.** Lenticellate bark observed on older woody stems. **C.** Close-up of dark coloured colleters at the base of lamina on adaxial surface. **D.** Flower bud with right contorted corolla lobes. **E.** Close-up of staminal column. **F.** Hyaline-membranous anther appendages artificially forced open to expose the pale green umbonate stigma. **G.** Close-up of a pollinarium showing dark-coloured corpusculum with two pollinia attached. (Photos: A, C.K. Yeo; B–C & E–F, Y.S. Yeoh; D, W.F. Ang; G, Y.W. Low)

Habitat and ecology. Forest margin and open forest gaps of disturbed lowland forests, to 230 m elevation.

Proposed conservation status. *Marsdenia maingayi* is proposed here for Singapore as Critically Endangered (CR), as the MacRitchie specimen is the only mature individual known to exist in the wild. This matches the status proposed in Davison (2008). This is largely due to habitat loss attributed to Singapore's economic transformation and development since colonial times.

Over its entire distribution the IUCN conservation status for *Marsdenia maingayi* is assessed using GeoCAT as Endangered EN B2ab(iii,iv) (IUCN 2001). The B2 designation is given because the Area of Occurrence (AOO) is estimated to be less than 500 km² (about 24 km² for *Marsdenia maingayi*); the 'a' designation because it is known to exist at no more than five locations (Singapore: MacRitchie Reservoir; Peninsular Malaysia: Kuala Aring Forest Reserve (Kelantan), Jengka (Pahang), and Gunung Panti Forest Reserve (Johor)); and the b(iii, iv) category indicates that there is a continuing decline in area and quality of habitat, and number of locations. Habitat loss is a major concern for the species as Peninsular Malaysia and Singapore continue to undergo modernisation. However, these proposed statuses for the species would require reassessment periodically as more efforts are underway in the region to systematically document the flora of Singapore, as well as the flora of Peninsular Malaysia.

Additional notes. Two sheets of the type material, *Maingay 1731* (Kew Distrib. No.: 1112) were present at Kew. As these were not clearly indicated in Forster (1995a), we would here like to designate the sheet identified by barcode K000821736 as the lectotype, while the other sheet (K000821737) is an isolectotype. At MacRitchie, the flowers of *Marsdenia maingayi* were observed to be visited by lepidopterans, *Quedara monteithi monteithi* (Wood-Mason & de Nicéville 1887), a dark-coloured skipper. A dark-coloured liquid, possibly nectar (Fig. 4), was also observed to be present. The nature of the dark-coloured liquid was not investigated, but was suspected to be produced by the plant as it was sweet to taste. Furthermore, coloured nectar has been recorded for other members of the Asclepiadoideae (*Hoya* R.Br. species) (Hansen et al. 2007). The plant failed to produce mature fruits after the end of the flowering period based on observations carried out by the first author on subsequent visits over a period of six months. *Ex situ* conservation attention for the species has been initiated at the National Parks Board's Pasir Panjang Nursery as this is the only known living specimen to exist in Singapore. As this species certainly has much ornamental value, given its large showy and mildly fragrant flowers that change from white to yellow-orange as they mature, it could be introduced to streetscapes in the near future. Special effort is also needed to protect and preserve this living specimen on site, in the vicinity of MacRitchie Reservoir, as a long term *in situ* conservation effort.

Additional specimens examined: PENINSULAR MALAYSIA. **Kelantan.** Kuala Aring Forest Reserve, 1992, Kiew KBH26 (KEP; SING! barcode no. SING0015422); **Pahang.** Jengka,

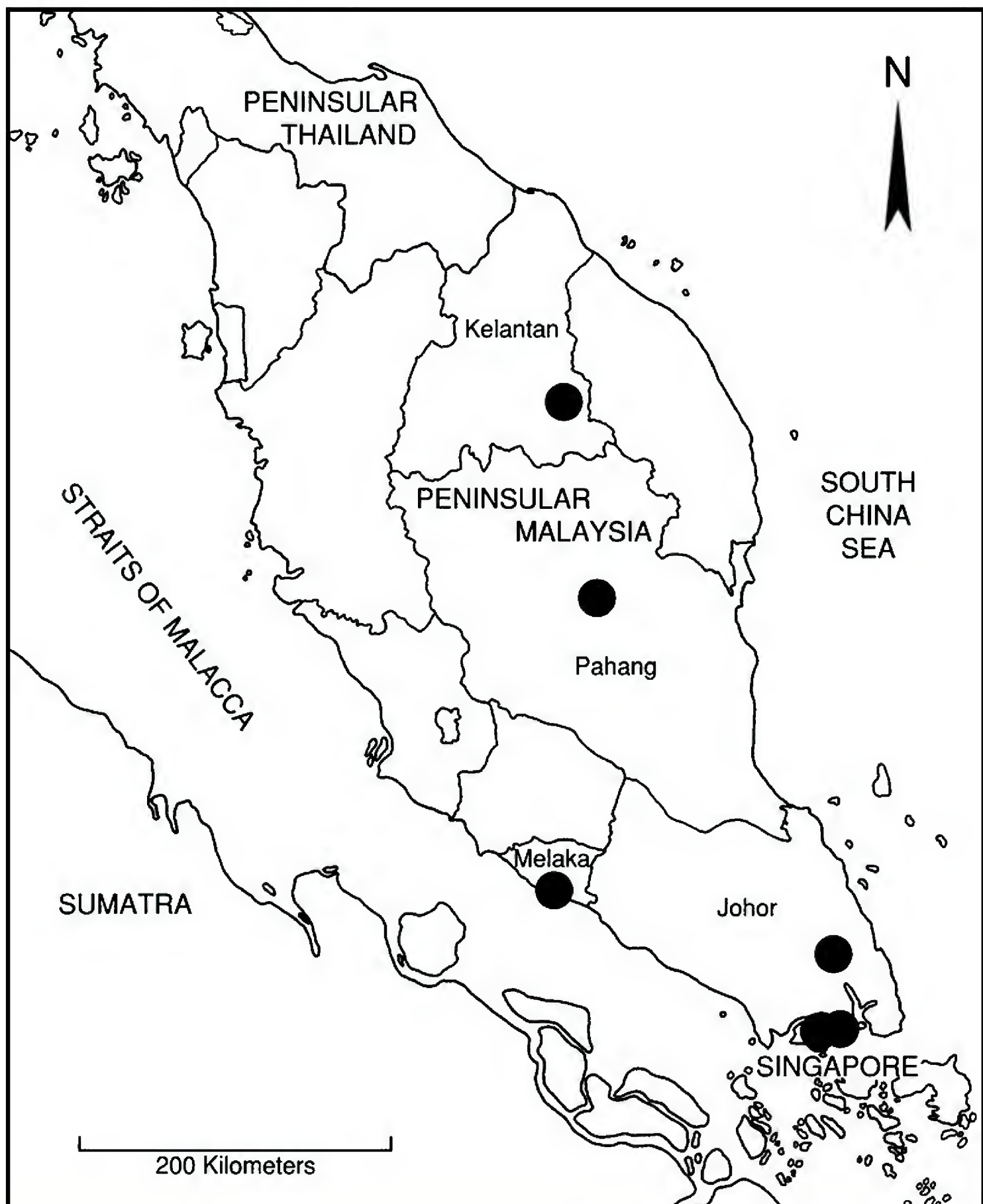


Fig. 3. Distribution of *Marsdenia maingayi* in the Malay Peninsula, indicated by black dots.

18 May 1983, Ng *FRI27408* (SING! barcode no. SING0122332); **Johor.** Gunung Pant, 22 May 1966, *Heaslett s.n.* (SING! barcode no. SING0122331). **SINGAPORE.** Changi, July 1885, *Hullett 147* (SING! 2 sheets, barcode nos. SING0003975 & SING0003974); Central Catchment Nature Reserve, MacRitchie Reservoir Park, 27 Aug 2012, *Low et al. LYW523* (K! SING! barcode no. SING0166282)



Fig. 4. The dark brown skipper, *Quedara monteithi monteithi* (Wood-Mason & de Nicéville, 1887), was spotted visiting *Marsdenia maingayi* flowers. (Photo: W.F. Ang)

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